# The Blast Furnace and Steel Plant

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***Published the first of each month by The Andresen Company Inc.***
**Main Office—Thaw Building, 108 Smithfield Street, Pittsburgh, Pa.**

President: **L. L. CARSON** Vice President: **GEO. A. ERB** Secretary and Treasurer: **M. M. ZEDER**

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New York, N. Y.

Subscription Price:—In the United States, $2 per year; Canada, $2.50; all other countries, $3.50. Single Copy, 25 cents.
Entered as second-class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.

The Blast Furnace and Steel Plant

Vol. XIII PITTSBURGH, PA., DECEMBER, 1925 No. 12

# Fifty Years of Growth

VERY few of our great American industrial organizations can boast of a half century existence. Fifty years of continuous operation is a long stretch of time, and many fundamental changes have taken place during that significant period. The steel industry itself, as we are now pleased to consider it, existed only in embryo.

But when an organization can refer to files dating back to 1875, it may well be proud of reference to its founders and their work—their limitations and their struggles.

One of the great organizations which has contributed greatly to the steel industry's progress and development has just now commemorated its fiftieth anniversary, and has issued a beautiful souvenir. No better picture could be drawn of the men and conditions in industry fifty years ago. The automatic, mechanical present is contrasted against the more personal, painstaking past.

"In those days men seemed to enjoy problems more. There was a wonderful thrill in meeting and whipping the unexpected. Engineering, as a science, was in its swaddling clothes, but our engineers tackled seemingly insurmountable obstacles with a blithe confidence which was at times hardly justified. The funny part, however, was that these men were rarely defeated. They didn't worry about crossing a bridge until they were right out in the middle of it—but the bridges were crossed.

"Men were not cross-indexed in those days. Methods were not cut to pattern."

"The efficiency engineer with his lost motion eliminators was unknown and unsung. Men just hit the line hard, tackled low and fought the best fight that was in them.

"They were the free thinkers—the real pioneers—and the spirit of such men is America's greatest industrial heritage. It explains why this country leads the world today in the mechanical arts. Our forefathers had the confidence and inborn gumption which the generation of today has inherited and put to such good modern use."

The story of this organization is a fair cross-section of most of our great organizations which have lived and prospered, chiefly because they clearly understood America's expanding needs and have been willing to help in supplying those needs.

# Detroit Becoming a Steel Producer

## Concentration of Motor Industry with Production of Over Four Million Cars Annually Will Be Met with Steel Production Expansion

THE growth of the automobile has made Detroit one of the great cities of America, and the further expansion of the motor-car and allied industries will of necessity make Detroit an important center of iron and steel production as well as consumption.

Eighty-five per cent of the motor cars are made in Detroit or within a fifty mile radius.

Mr. E. Y. Watson, an authority on industrial conditions, summarizes the situation with unmistakable optimism:

"Nineteen twenty-five is certain to beat all existing records of motor car production in America, according to the present outlook. That will mean that more than 4,086,000 cars will have been turned out from factories in Detroit and elsewhere by December 31. This is the previous high mark reached in 1923. What the new record total will be, of course, is a matter of conjecture as yet, but Alfred Reeves, general manager of the National Automobile Chamber of Commerce, who was in Detroit recently, placed it at beyond 4,200,000. This, to be sure, is a staggering figure which the output of all factories in the Detroit district for October will help to achieve.

**Plants at Maximum.**

"There are reasons for this; briefly these: Ford which is climbing toward 10,000 cars a day, will monthly make and sell 200,000 vehicles while General Motors with all five plants running at full capacity, expected October to beat September. In September, it will be recalled, General Motors had its record month of all time, delivering to dealers 88,379 vehicles.

"Factories in the Detroit district with the exception of one or possibly two, are on a similar proportionate basis of volume and there are scarcely any plants in the price class below $1,500 that have not made more cars in the first nine months of this year than they did in the entire 12 months of 1924.

"That October, usually one of the lower months of the year when the plants "'taper off" in volume, will be better than September is forecast by figures of the Employers' Association which shows that as of October 22, there were employed in two-thirds of the factories here 70,563 more workers than at the same time 12 months ago. With this may be linked the information that the Ford Motor Company, recently reached a new high peak for employment with 178,000 persons on the pay rolls.

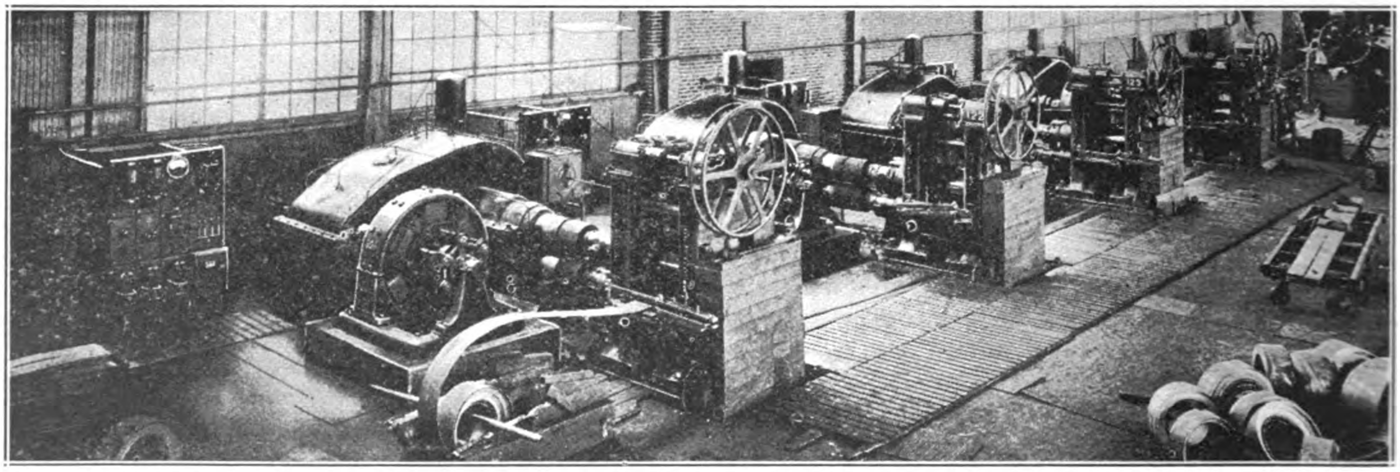
**Magnates Surprised.**

"Ever since April when total volume of all plants exceeded all monthly records of the past, each succeeding month has bettered the corresponding one of 1924 and the country wide demand for cars has surprised even the factory magnates themselves in the strength it has maintained. Up to now so great has been the call for cars, that dealers have had no opportunity to accumulate stocks. They have been able to dispose of practically all the cars they could get and with several of the more popular makes, have had to keep customers waiting for weeks at a time. They have been faced by a more or less over-sold condition ever since March. At that time few in the trade had any idea of what was coming and the factories put out strong propaganda to the effect that the practice of forcing cars on the retail interests to their detriment was a thing of the past.

"Now, however, the situation is reversing itself. The year so far has been so profitable for the dealer arm of the industry that the larger distributors are willing and even eager to accept cars in quantities beyond their immediate needs in the belief that 1926 is going to show an improvement over 1925.

**Mr. Chapin's View.**

"In some quarters it has been contended that the amazing totals of cars absorbed by the country at large during the past nine months are due to the fact that America is having its first great closed car year



*Strip mills serve the motor trade. Four-tandem cold strip mills driven by four 250 hp., 400-800 rpm., 230 volt, d.c. General Electric motors at the Detroit Steel Corporation.*

and that the business of past months has involved a complete turn-over from the open to the closed models.

"With this view, Roy D. Chapin, president of the Hudson Motor Car Company, in an interview credited to him takes issue. He declares that he has little faith in the statement that much of the current year's production is due to an increase in the demand for closed cars that would be satisfied as soon as many drivers of open cars had turned them in for closed models. Closed cars, he says, always will be in demand, and once a man has driven a closed car and is impressed with its utility and comfort, he will be just as anxious to replace it with a new closed car as he was to turn in his open model.

"As far as can be told now, Mr. Chapin thinks, next year should bring the motor industry business as great as this year.

**Prices at New Low.**

"While Alfred Reeves was here, he pointed out an added factor in the demand not previously taken into consideration; that is that the average buyer today does not have to pay the full retail price because he usually has a car to trade in.

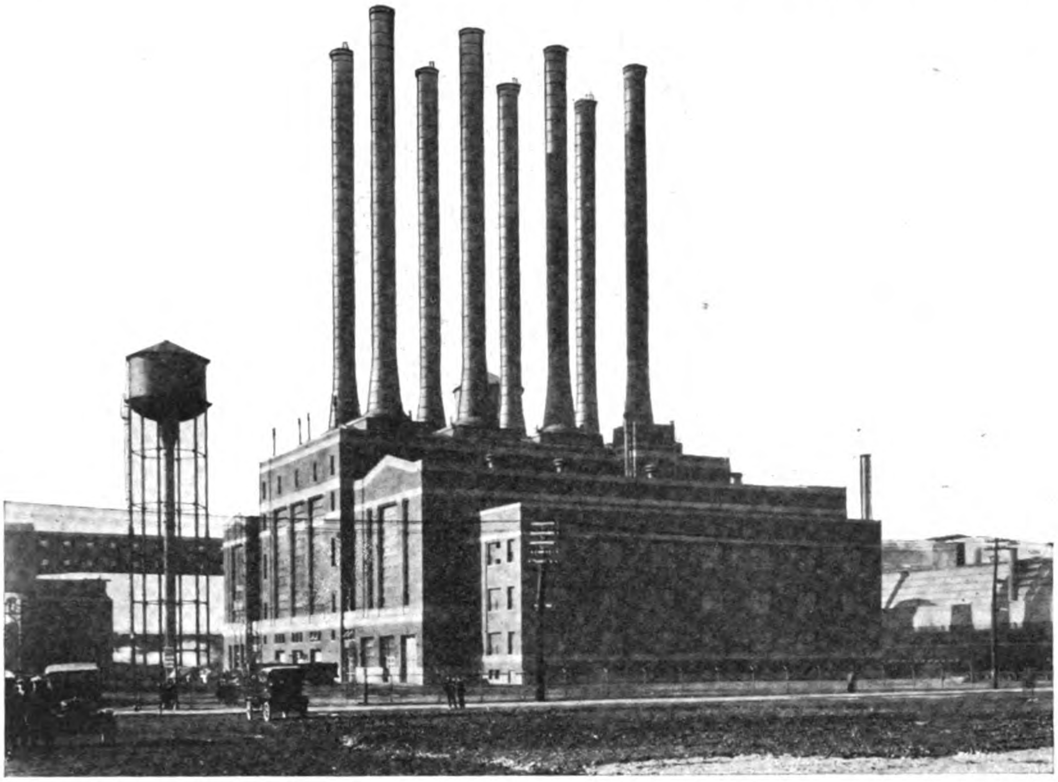
"Mr. Reeves also imparted another salient reason for the extraordinary increase in sales. Price reductions of the past summer have made new cars 30 per cent cheaper than they were before the war.

"The manufacturers," he said, "have kept faith with the public and passed on to them the savings of improved methods, making their profits in the volume of business rather than on the individual unit.

"The increase of automobile exports to more than half a million vehicles this year, Mr. Reeves regards as promising added prosperity for the plants in this city and elsewhere. He expects that foreign trade will reach the mark of 1,000,000 vehicles soon."

The influence upon the steel industry with such an enormous consuming capacity in sheets, bars, light structural spring steel, forgings, high speed steel, and castings cannot fail to be far-reaching.

Especially is this so since Detroit is an ideal location for major steel production. No city in America can offer more. Midway between ore and coal, located directly upon lake navigation with unlimited deep-water harbor capacity, the district itself a natural market, and centrally located to reach interior markets by many excellent railroads, and also export markets by direct steamship cargo; all this combined with the best of topography for expanding plant needs, and an uninterrupted opportunity for home sites within striking distance of exceptional agricultural territory. Not even the South offers these many advantages.



*Large extensions are being made to the Ford River Rouge power plant. The original 2,680 hp. Ladd boilers have been considerably enlarged. One 30,000-kva. generator has been completed, and plans provide for four additional generators of the same capacity. When all the additional units are installed, the Ford company will have sufficient power to meet the requirements of its River Rouge plants, will supply some power for its Highland Park plant, power for the partial electrification of the Detroit, Toledo & Ironton Railroad and will probably have some power to sell. Electric locomotives are now being built at the plant for operation on the Detroit, Toledo & Ironton Railroad.*

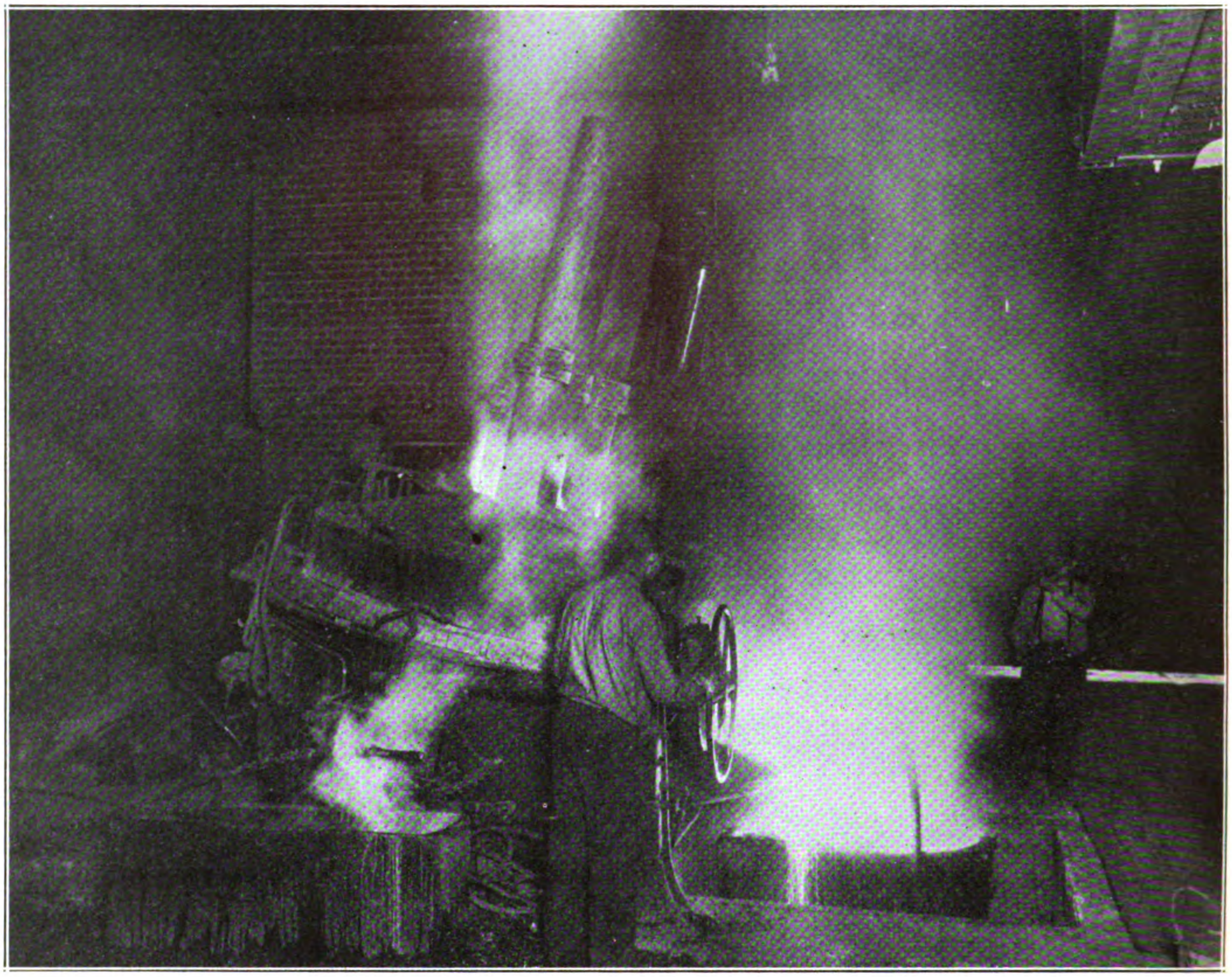
For many years Detroit has been a substantial producer. The American Car and Foundry Company have been operating bar-mill capacity exceeding 100,000 tons per year, The Detroit Seamless Steel Tubes Company roll 35,000 tons of tube blanks, and produce 25,000 tons of finished tubes. The Michigan Sheet Steel Company have one of the most modern strip mills in the country. An interior view of four motor driven mills is shown in the first figure. Detroit Steel Casting Company produces more than 20,000 tons yearly, partly open-hearth steel castings, and the Michigan Steel Casting Company approximately the same total, but all electric steel castings. The Detroit Iron and Steel Company owned by the Hanna interests, have operated two blast furnaces on the River Rouge since 1903, producing 240,000 tons of iron per year.

The Ford Motor development at River Rouge begun in 1917 during the war, and put in operation in 1920, turned serious attention toward Detroit as a great iron and steel possibility. The details and character of these two blast furnaces, with their adjoining foundry cupolas, designed to charge molten metal direct from furnace to cupola, and their huge power plant designed to burn blast furnace gas, pulverized coal or coke-braize and tar separately or in combination, created an epoch in the design and operation of blast furnaces. 400,000 tons measure this annual capacity.

From this blast furnace installation, the next logical step is toward steel capacity. Four 125 tons open-hearths are under construction, with an ultimate layout calling for 26 additional.

## Rolling Mill and Forge Shop for Electric Alloy Ingots.

The new steel plant of the Ford Motor Company, Detroit, will be equipped with a 42-in. continuous blooming mill, a 32-in. billet mill, and a 14-in. 4-stand merchant bar mill. Alloy steel forging bars will be rolled from ingots made in a 50-ton Greaves-Etchells electric furnace which, with two 10-ton electric furnaces of the same type, has already been installed. The product will be formed into automobile parts in a new forging plant that is now being erected at the Ford company's River Rouge plant, where the steel plant will be located.


*View of the 1½-ton per hour 'Lectromelt furnace installed in the plant of the Detroit Steel Casting Company. The photograph was taken shortly after the furnace was put into operation and the preliminary heats had been run.*

The blooming and billet mills, which are being built by the Morgan Construction Company, will be a radical departure in rolling mill design. Each mill will consist of four 2-high stands arranged in line. In the eight continuous passes through the mill stands an 8x12 in. ingot 55 in. long or about 1,500 lb. will be reduced to a 4x4 in. billet. Later it is the intention to add two additional stands at the front end of the blooming mill; these will permit the reduction of 3,000-lb. ingots. The plant will have an approximate capacity of 100,000 tons of ingots and billets per month. The layout provides for two units in addition to the 14-in. bar mill for reduction of the steel after delivery from the combination blooming and billet mills. These will be an 18-in. sheet bar mill and an 18-in. billet mill.

The Ford company plans by the building of a steel plant to effect further saving in its manufacturing processes by the elimination of the transportation of scrap produced in its plant to other steel mills to be reconverted into finished steel and shipped back to the Ford plant. Although much of the scrap produced is consumed in the Ford blast furnaces and foundry cupolas, much of this scrap material now finds its way to steel plants in other districts. With the completion of its steel plant the Ford company expects to convert daily 1,000 to 1,500 tons of scrap into steel.

The Ford company now has a motor assembly plant 600x800 ft. under construction at its River Rouge plant. When this is completed assembled motors will be shipped direct from this plant to distributors instead of being sent to the company's Highland Park automobile plant and shipped out with other dissembled parts, as is done now. This will apply to motors for all cars except those distributed in Detroit and immediate vicinity. The other parts of the car will be shipped from the Highland Park plant as at present. Considerable saving in transportation will be effected by making the shipment from both plants. Adjoining the motor assembly plant a machine repair shop, 160x 180 ft., is being erected.

The company has placed its new cement manufacturing plant in operation. This is equipped with one kiln with a daily capacity of 1,000 tons which will convert the slag from one blast furnace into cement. A second kiln will be added later to handle the slag output of the second furnace.

### Non-ferrous Rolling Mills.

Of parallel interest to rolling mill and electric furnace men has been the growth of the non-ferrous industry. Just as much of the iron and steel tonnage has moved from other producing centers like Pittsburgh, Cleveland, Chicago, etc., to Detroit, a coming producing center; so has the copper and brass tonnage requirements been transferred from the Naugatuck Valley in Connecticut to its later home in Detroit. Two great concerns have grown and prospered. Since 1906 the output of one, the Michigan Copper & Brass Company has expanded from 250,000 pounds per month to the present 50,000,000 pounds.

In these non-ferrous mills the same general physical tendencies have been shown which have marked progress in iron and steel. Motors for driving main rolls and auxiliaries have largely displaced the steam engine. Metal and materials that were originally transported about the plants on wagons or by hand are now moved by the systematic operation of electric cranes, inter-plant tractors and the like.

Rolls that run at a speed calculated to astonish the old time roller turn out metal in 24 hour continuous operaton, from the largest thin sheet mill in the world.

Electric furnaces have almost entirely eliminated the pit fire and crucible, and produce a finer and more uniform quality of metal in less space, with fewer men, and with greater safety.

The original rod mill, with its one stand of old fashioned three high rolls has been almost entirely done away with, and a new department with extrusion machines takes its place.

### Conclusion.

When we view the foregoing developments in the light of conditions ushered in by the present century, when we see the comparative census figures of 1900 and 1920 and find that a peaceful residential community has been converted into a hive of industrial activity supporting a million population, it requires only the slightest imagination to carry the analogy to its ultimate conclusion,—steel will be made at the door of its greatest customer.

## History of Steel Making Traced in Sir Robert Hadfield's Collection

When the Mining and Metallurgical Congress was held at the British Empire Exhibition at Wembley, England, last year attention was directed to the lack of accurate knowledge of the physical chemistry of steel making processes. As a result, it was decided to appoint a committee to arrange for further discussion of the important problems involved, and a meeting held during June at the Institution of Civil Engineers (London) by the Faraday Society and the Iron and Steel Institute was the outcome of steps taken by the committee. A representative attendance was secured and the papers presented dealt with many aspects of the subject.

Sir Robert Hadfield, who occupied the chair, said that the committee had obtained in the form of papers an account of the work carried out in the United States, Canada, and Great Britain. To assist in elucidating some of the problems which face the iron and steel industry in regard to the physical chemistry of steel manufacture, Sir Robert brought together for the inspection of those attending the meeting a small collection of very interesting exhibits illustrating the history and development of steel making.

The exhibits comprised ancient materials, including chippings from the old iron pillar of Delhi, dating from about the third century B.C.; an iron cramp from the tomb of Cyrus, founder of the Persian Empire; specimens of Sinhalese iron and steel, and nuts and bolts from a Viking ship of the eighth century. The modern exhibits revealed the latest developments in electrical melting, including the utilization of X-rays. Among old metalurgical literature from Sir Robert Hadfield's is the Liber Mineralium of Albertus, written in 1505, which carries the industry back to the earliest attempts to obtain a scientific understanding of the nature of iron and steel.

Sir Robert thinks it would be desirable to have an adequate portrayal of the history of steel manufacture in the form of a national exhibit in the famous Science Museum in London. An exhibit of the character he indicates could be formed, with the assistance of those owning private collections, and would be not merely of historical interest, but of great practical value.

The papers presented at the meeting included: "Physical Chemistry of Steel Making," by Sir Robert Hadfield; "Balance Reactions in Steel Manufacture," by Dr. A. M. McCance; "Reactions of the Basic Open hearth Furnace," by T. P. Colclough; "Slag Reactions," by Dr. Peter M. Macnair; "Ferric-oxide in Acid and Basic Open Hearth Slags," by J. H. Whiteley; "Physico-Chemical Phenomena from Melt to Ingot," by A. L. Field, New York; "Reactions of Basic Electric Process," by F. T. Sisco, U. S. Army Air Service, and "Equilibria in Systems Involving Ferrous Oxide," by J. B. Ferguson, Toronto.

# Defective Material and Processes*

### The Main Object of This Paper Is to Commend the Use of Simple Means of Investigation for Defects Such as Pickling, Etching and Sulphur Printing

By **HARRY BREARLEY**

PART II

A GREAT number of defects come to light, in service or under test conditions when there is no suspicion of anything being wrong. It is possible to judge the surface condition of raw steel by inspection or ensure its goodness by machining. But the condition of its interior cannot be explored except by etching or sulphur printing, two forms of inspection which are not much used at present although many are aware of their value in isolated cases, of which the following is an example:

The round billets supplied to tool makers are frequently pierced on a rotary piercer. During this operation the hot billet is rapidly revolved and fed forward over the end of a conical piercing point. The friction of the rotating discs or rolls on the outside of the billet, and the piercing point on its inside, tends to shear the hollow billet in the thickness of its walls. Actual shearing may take place as seen in Fig. 7, which represents the partly pierced billet cut longitudinally in order to release the piercing point. The production in this way of two tubes where only one was intended is not regarded favorably by the tube maker.

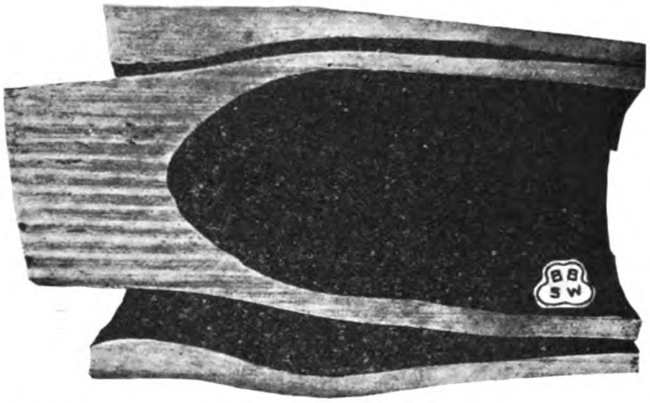


FIG. 7—*Longitudinal section of partly pierced tube showing effects of shearing action.*

The interest of this mishap lies in its unexpected cause, a sulphur print of the sectioned surfaces is shown in Fig. 8. Fig. 9 is a sulphur print of a section cut through the part where the inner and outer tubes were not separated.

It is to be observed that the partly pierced billet has sheared along a surfac ewhich sharply divides it into low sulphur and high sulphur material. Drillings taken from the two parts had the following composition:

| | Outer Part | Inner Part |
|---|---|---|
| Carbon ............ | .06% | .14% |
| Silicon ............. | Trace | Trace |
| Manganese ......... | .40% | .46% |
| Sulphur ........... | .023% | .077% |
| Phosphorous ....... | .017% | .034% |

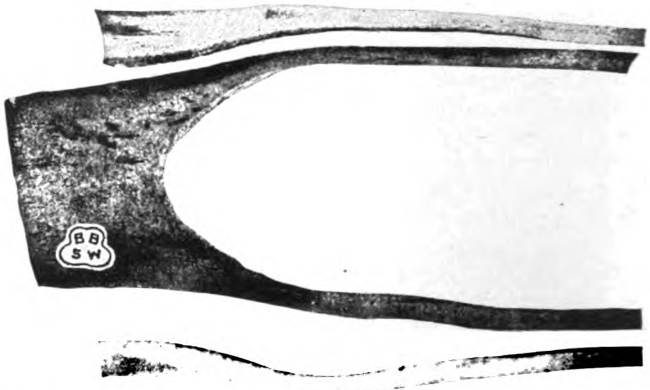


FIG. 8—*Sulphur print from section shown in Fig. 7. Note that shearing has taken place on a plane dividing high and low sulphur material.*

Reference is made to sulphur because its distribution can be detected by the particular method of printing adopted. The carbon and phosphorus also are segregated but none of these segregates are directly responsible for the defect. On the sulphur prints represented in Figs. 8 and 9 a number of dark spots are visible; these are especially noticeable in Fig. 9 along the line between the inner and outer pieces. These dark spots clearly indicate that the ingot from which the billet was made was a blown ingot. Its history was probably something like the following: The fluid steel cast from a fairly high temperature first chilled against the inside of the mould into an envelope of chill crystals. These chill crystals now form the outer tube of the defective specimen. After the chill crystals had completely formed, the fluid interior of the ingot began to liberate gases which kept the mass in continual movement until its freezing temperature

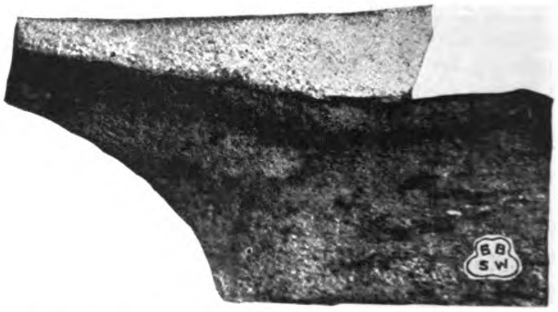


FIG. 9—*Sulphur print on a section cut where inner and outer tubes were not separated.*

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*Paper read before the Coventry (England) Engineering Society and reprinted from the Journal of the (British) Assoctation of Drop Forgers and Stampers.

was reached. This movement of the partly fluid ingot accounts for the fairly general distribution of sulphur in its interior. The dark spots represent blowholes entangled in the pasty steel and into these blowholes the very richest segregates would be squeezed as the adjacent solid crystals began to contract. These blowholes would ultimately be most abundant on or about the planes dividing the chill crystals from the interior metal.

The explanation would no doubt be more convincing if a piece of the ingot from which the billet was prepared could have been examined. This was not possible, but Fig. 10 is a sulphur print taken from an ingot made as described. It is easy to see the likeness to the defective billet both as to outer chill crystals and especially as to the line of blowholes on the interior surface of the chill crystals.

Three kinds of defects arise from grinding, viz., hard patches, soft patches, and defective surfaces, which are not particularly hard or soft. An example of defective surfaces is to be found on most railway tires which have been heavily braked. Under the repeated heating and cooling caused by frictional resistance between the brake and the tire the tread develops numerous small cracks. It is difficult to determine whether the tread is alternatively hardened and softened or not. It becomes mechanically hardened of course, and that in itself accompanied by local flow in the steel as indicated in Fig. 11 may ultimately produce the shelling illustrated in Fig. 12, which is usually associated with deep seated cracks as seen in Fig. 13. Occasionally the brake may overlap the tire flange and if the braking is frequent and heavy the flange is sure to form transverse cracks, as seen in Fig. 14, which may penetrate some two or three millimeters into its surface. A high tensile steel tire can easily be fractured through one of the cracks.

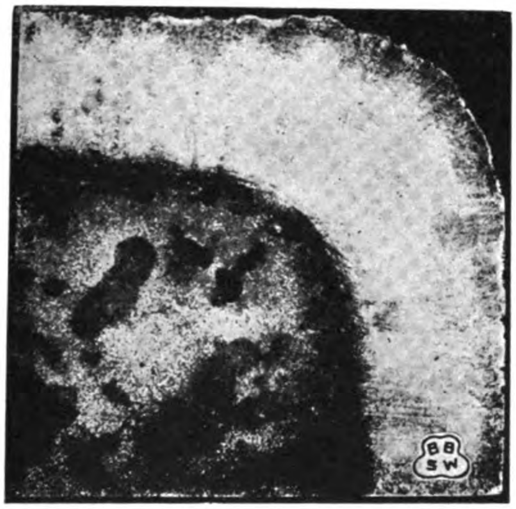

FIG. 10—*Sulphur print from blown ingot.*

On grinding, a soft surface may be hardened, or a hard surface may be softened. Some flat spring steel bars in the rolled condition were being prepared for tensile testing when the milling machine broke down. They were finally shaped on a heavy grinding machine. On testing, every ground piece broke prematurely and on examination small cracks were apparent on each of the ground surfaces as indicated in Fig. 15. After polishing and etching it was clear that under severe grinding the extreme surface had become hot enough to harden under the conductive cooling effect of the mass of the spring bar. The thin layer of hardened steel on the ground edge of the bar may be clearly seen in the top part of Fig. 15, and the numerous small cracks are also visible.

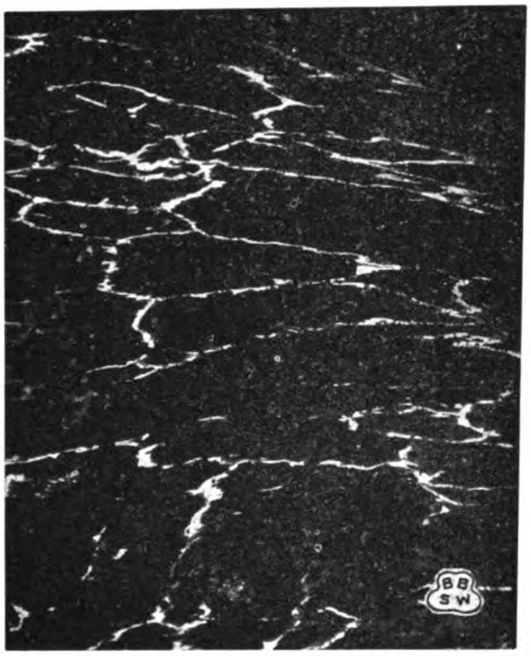

FIG. 11—*Microphotograph showing flow on tread of locomotive tire.*

On the other hand the softening of the surface of hardened steel by grinding is not an uncommon occurence. Many parts are made that are hardened before grinding and great care must be exercised to prevent the appearance of defects in this operation. The fact that grinding sparks are visible, whatever amount of cooling water is used, is an indication that some part of the ground surface has been momentarily heated. Each spark is a particle of incandescent metal or a small molten glouble of steel torn from the mass with force enough to raise its temperature far beyond visible redness. The furrow left on the torn surface has also been heated to some extent, though one can form only a rough estimate of the actual temperature attained.

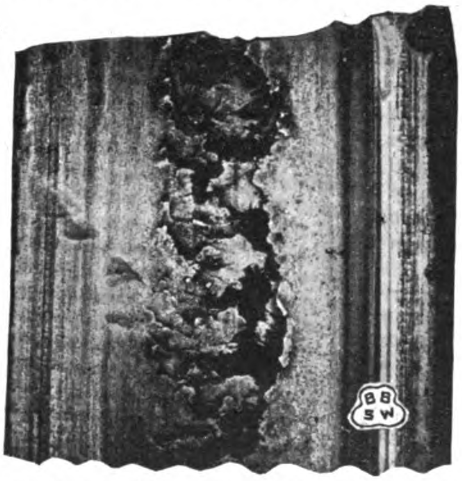

FIG. 12—*Shelling on tread of locomotive tire.*

Soft places produced on grinding hard surfaces are easily disclosed by means of etching with an alcoholic solution of nitric acid.

Distinct results can sometimes be produced by very dilute solutions of nitric acid in water. A solution of a few tenths per cent of nitric acid contained in a receptacle in which the bright object can be suspended for 10 minutes or more will often give clear evidence when stronger solutions acting more rapidly will be confusing.

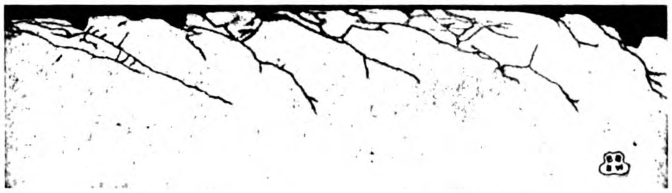
FIG. 13—*Deep-seated cracks on tread of "shelled" tire.*

The hardening of drop-forging die blocks offers many problems and brief reference to this subject might be of interest. The direction in which the forging grain lies and the general soundness and suitability of material for die blocks are now being taken care of by a recently drafted specification. But how hard should the hardened dies be made, and how deep will the hardening effect penetrate? On examining a series of broken dies two kinds of defects recurred with great frequency. The hardened faces were too shallow and the dies had been insufficiently tempered before using.

Fig. 16 is a contact print of a section through a circular block which had cracked badly in both radial and peripheral directions. The depth of hardness penetration is indicated by the dotted line, but is otherwise made visibile by the diffused condition of the surface material. The layer of hardened steel is most shallow in the depression where the working stresses are greatest. On Brinelling a case-hardened object the hard surface is damaged because it cannot follow the distortion of the softer material underneath it without cracking. In the same way the hardened surface of a die block if too shallow, is readily distorted into a crack by temperature effects or it may be directly stressed into a crack by the hammer blows. It is obvious that the die block represented by Fig. 21 would be most likely to break at the bottom of the semi-circular impression because in that position the steel was only superficially hardened.

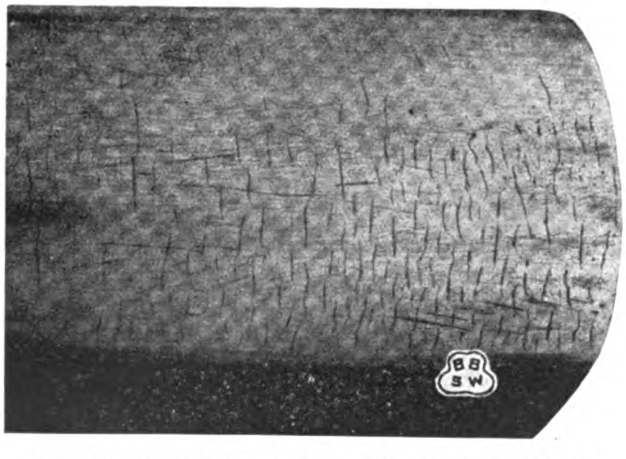
FIG. 14—*Transverse cracks on flange of tire due to heavy breaking.*

Of a score hardened die blocks examined eight of them at least had probably gone into service either untempered or tempered only at low temperatures. This seemed apparent from the high Brinell hardness numbered (500 to 600) of the material on the working face but not in the actual impression. In the impression itself the material was much softer and it was generally softest in the largest part of the impression. These observations suggest that the hardened and insufficiently tempered dies were further tempered in and about the impression by the hot steel brought into contact with these parts. As no condition could be more favorable to cracking, the fact that each block is reported to have cracked after a very short life is not surprising.

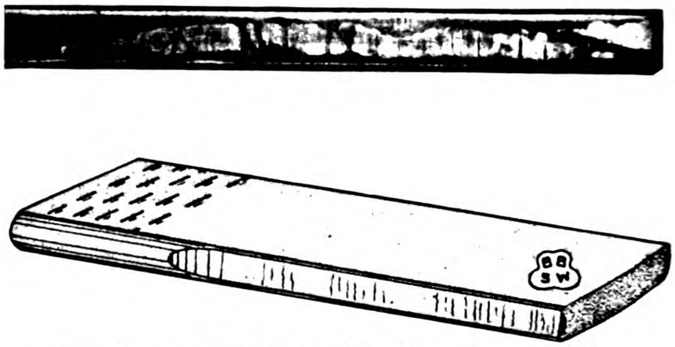
FIG. 15—*Cracks in layer of hardened steel caused by rash grinding.*

The impression in a hardened die must inevitably be tempered during the actual forging operation and the tempering effect will ultimately reach a maximum and proceed no further. If such tempering is inevitable it would be better to temper the whole block to that extent under controlled conditions.

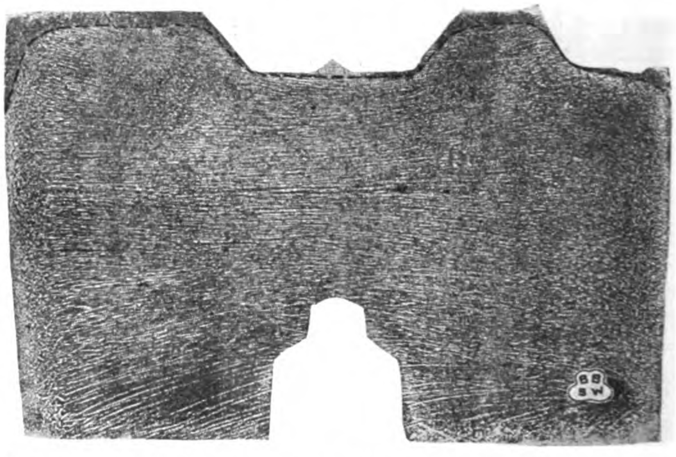
FIG. 16—*Macro print from cracked die block. Note shallow hardness penetration on working face indicated by dotted line.*

A final reference is made to the burning of steel because makers of billets, bars, rods and tubes, as well as forgers, burn material without knowing it, and are, therefore, prone to believe that such a mishap does not occur in their furnaces. It would help greatly if every person responsible for the hot working of

(Concluded on page 477)

# SHEET AND TIN PLATE

# Silicon Steel*

## A Large Increase in the Use of Silicon Sheets Will Follow the Electrical Industry's Expansion

By W. E. RUDER†

As one of the most common and widely distributed elements found in nature, silicon has always been associated with the analysis of steels and its effect upon the properties of steel, in the fractional percentages in which it is usually found therein, is so familiar to every steel man that it is hardly necessary to consider it at this time. It is only when this element is added or retained in some definite proportion that the product may be truly called an alloy steel in the accepted sense of the term, and it is to be so considered in the present discussion.

As far back as 1885 Hopkinson[1] studied the magnetic and electrical properties of silicon alloys containing up to 3.4 per cent silicon, and in 1896 Parshall[2] discussed the effect of 1 per cent silicon upon the magnetic properties of steel, but no real interest was aroused in silicon steels until Hadfield,[3] who in 1889 had published the results of his more complete investigation of the mechanical properties of a series of silicon alloys, published in 1900 with Barrett and Brown[4] the results of tests on magnetic properties. While these did not show values any better than had been obtained on good unalloyed materials, the improvement over the basic materials was promising and this, combined with the high electrical resistivity, was quickly recognized as being a desirable combination of properties for a core material for electrical apparatus. Gumlich[5] of the German Reichsanstalt was one of the first to see the possibilities in the Hadfield alloys and as a result commercial production of steels was in full swing in Germany by the end of 1903.

In the United States the commercial production of sheets was also quickly established and one of the leading electrical companies made its first silicon steel core transformer in 1904 and by 1905 the new core material was in regular production. In fact, the beneficial effect of small quantities of silicon had already been recognized in 1896 in this country as a cure for excessive ageing, and its use adopted by Mr. J. F. Kelley of the Stanley Electric Company.

Since the original work by Hadfield, a great deal of detailed study of the magnetic and mechanical properties of iron-silicon alloys has been carried out. The most careful work done in this field has been published by Gumlich[6] and Yensen.[7]

### The Constitution of Silicon Steel.

Silicon forms a solid solution with iron up to 20 per cent, and the compounds FeSi (at about 34 per cent) and $FeSi_2$ (at about 50 per cent) have been demonstrated by X-ray and density measurement methods. The most important effect of silicon in the critical points is the raising of the $A_3$ point and its disappearance at something near 2 per cent Si, while the magnetic change point is gradually lowered from 740 deg. C. at .11 per cent Si to 670 deg. C. for 4 per cent Si. Carbon is retained in solution up to about .008 per cent with silicon up to at least 5 per cent. Carbon above .008 per cent in annealed steel appears as pearlite and cemetite up to 4 per cent silicon and, with over 4 per cent Si, as graphite.

### Mechanical Properties.

Silicon steels are forgeable up to 7 per cent of silicon, but the practical limit for steel rolling is around 5 per cent, most manufacturers preferring to keep below 4.5 per cent.

Silicon increases the tensile strength of pure iron from 38,000 to 90,000 at 4.5 per cent Si, and the yield point from 15,000 to 70,000, in annealed samples. With more than 4.5 per cent Si the strength rapidly falls to about 10,000 lbs. at 6 per cent. The elongation (50 per cent) and reduction of area (80 per cent) are but slightly affected up to 2. 5 per cent. With higher silicon these values decrease rapidly.

For carbon steels, properly heat treated, strength up to 300,000 lbs. per sq. in. with a yield point of 294,000 may be obtained. For use as springs a heat treated silico-manganese steel containing about .50 per cent C, .50 per cent Mn and from .5 per cent to 2.2 per cent Si is used. Such steels have a yield point of from 175,000 to 275,000 lbs. per sq. in., with an elongation of from 5 per cent to 3 per cent. These steels are limited in their use by their low impact strength and are not used where high resistance to shock is required.

### Magnetic Uses.

By far the greatest economic value of silicon steel has been in its use as a core material for electrical apparatus, particularly in transformers. Twenty-five years ago the best material available had a loss of over 1¾ watts per lb. at 10,000 B and 60 cycles, and was very unstable. When freshly annealed it might have such a value, but if tested after a year's service this value was frequently found to have doubled. With such limitations, the progress made by the electrical industry today would have been impossible. Many attempts have been made to estimate the value of silicon steel in terms of savings in power, but anything like an accurate estimate is impossible. If we consider only the transformers made in the United States, and assume that only those made during the last 10 years are in service now, the saving in watt loss alone for 1925 due to the use of silicon steel comes to $15,000,000 per year, which yearly saving is being added to, at the present rate of transformer production, to the amount of approximately $3,000,000 per year. These figures do not take into consideration the large saving in material and construction expense over that required to produce the same capacity in transformers with non-silicon cores.

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*Paper read before the American Iron and Steel Institute, at New York, October 23, 1925.

†Research Laboratory, General Electric Company, Schenectady, N. Y.

[1] Hopkinson (1885) Phil. Trans., 176, 455.

[2] Parshall (1896) Min. Proc. Civ. Eng., 126, 220.

[3] Hadfield (1889) Journal Iron & Steel Inst., Vol. 2, p. 222.

[4] Barrett, Brown and Hadfield, Sc. Trans. Roy. Dublin Soc., VII (1900).

[5] Gumlich—Trans. Faraday Soc. (1912), 8, p. 108.

[6] Gumlich, Phys. Abt., Phys. Tech. Reichsanstalt (1915-18).

[7] Yensen, Univ. of Ill. Eng. Exp. Sta. Bull. 83 (1915); Journal Amer. Inst. Elec. Eng., 43, 558 (1924).

Transformers of over 50,000 kva. capacity are now being built with silicon steel cores, but it is doubful if machines of half this capacity would be practical without silicon steel, because of their bulk and weight.

While the greatest usefulness of silicon steel has been in the construction of transformers, the last decade has witnessed a rapid growth in its use for motors and generators, so that the production of "electrical sheets," as they are now generally termed, has taken an important place in the steel business of the country.

**Magnetic Properties.**

The first silicon steel produced in sheet form tested well over 1 watt per lb. (29 gauge, at 10,000 B and 60 cycles) and varied considerably in its quality. It was early recognized that, in order to get the best magnetic results, impurities[8] must be reduced to the lowest practical minimum and that the steel must be clean and well made. It was also found that the grain size[9] and residual strain had an important effect upon the results. The application of improvements in quality of steel analyses, annealing, and handling have resulted in a steady decrease in watt losses, so that to day a large percentage of the silicon steel made in the United States tests well under .7 watt per lb. (29 gauge, at 10,000 B and 60 cycles) and research work has produced sheets testing well under .5 watts per lb.[10]

Yensen[7] has shown that very small percentages of carbon have a tremendous effect upon the hysteresis losses. He estimates that silicon steel with .008 per cent C has eight times the hysteresis loss of the same alloy with .001 per cent C. While the possibility of producing this alloy with as low carbon even as .008 per cent at a rate of 50,000 tons per year now seems rather remote, the reward for the practical production of such a new material makes any amount of effort worth while.

The beneficial action of the silicon is due, first, to its pronounced effect upon the resistivity, which increases 11.4 microhms for every per cent of Si; second, to its effect in limiting the solubility of iron for carbon; and third, to its action in promoting grain growth.

The increased resistance limits the eddy current, but the grain size, if too great or irregular, may reverse the beneficial action of high resistance[11] to a large extent, due to the difference in magnetic permeability of the differently oriented grains.[12]

The effect of silicon is not all on the credit side, however, as it decreases the saturation value from B = 22,300 for pure iron to B= 20,200 for 4 per cent silicon and increases the brittleness of the alloy. In transformers this brittleness is not a serious handicap for the benefits for physical properties are that the material be soft enough to cut with a die without breaking. In rotating apparatus, however, both of these factors are a decided disadvantage. In many of these a portion of the steel is operated at the saturation point, and any reduction means that just so much more steel must be used to carry the flux. The item of mechanical strength and resistance to vibration and shock must be considered in rotating apparatus and brittle material cannot be considered.

For this reason it has become general practice to produce several grades of electrical sheets which have been given various trade names by different manufacturers. By variation in analyses and selection, manufacturers are now making about six different grades. For our present purpose the following will suffice:

(1) General Grade—Sheets containing from ½ per cent to 1 per cent of silicon are used in machines where watt losses are of secondary importance to high magnetic saturation value. The low percentage of silicon is sufficient to limit the ageing. Sheets containing about 1 per cent silicon are frequently classed by themselves under the general term of "electrical sheets." This term is, however, apt to be confusing on account of its general application to the entire class.

Watt losses in this grade very from 1.75 to 1.25 watts per pound at 60 cycles and 10,000 B for 29 gauge sheets.

(2) Motor Grade—Sheets containing from two to three per cent of silicon have in recent years come into wide use for alternating current motors and generators. This silicon content allows the minimum in watt loss, without danger from brittleness.

(3) Transformer Sheets contain from three to four and one-half per cent silicon, depending upon the quality desired and the practice of the manufacturer. The lower percentages are sometimes used for low frequency (25 cycles) aparatus. However, most transformers are made from sheets containing about 4 per cent of silicon. Manufacturers guaranteed lossess for this grade range from .75 to .98 watt per lb. at 10,000 B and 60 cycles for 29 gauge.

**Thickness of Sheets.**

Magnetic loss, as expressed above, has two components, hysteresis loss and eddy current loss. The former decreases slightly with the thickness of the sheet, while the latter increases with the square of the thickness. It is therefore necessary to make the sheets of such thickness that the eddy currents are at a minimum, consistent with a minimum hysteresis loss. In this country .014 in. is commonly used for 60-cycle apparatus. In higher frequency apparatus, such as is used in radio, the eddy current losses predominate and sheets .003 in. and less are required.

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[8] Ruder, G. E. Rev., 18, 197 (1915).

[9] Ruder, Trans. A.I.M.E. (1913), 2805.

[10] Yensen, discussion, Journal Amer. Inst. Elec. Eng. 43, 1066 (1924).

[11] Ball & Ruder, G. E. Rev. 17 48 f (1914).

[12] Ruder, Trans., A.S.S.T. (1925).

**Effect of Punching Strains.**

Hysteresis losses are practically sensitive to mechanical strain so that a through anneal must be given to remove all of the strains imparted by rolling. This is usually done by the manufacturer and upon the thoroughness and uniformity of this anneal much of the quality of his product depends. Before the steel can be used in electrical apparatus, however, it must be cut or punched into the required pattern and this operation introduces strains which increase the losses and decrease the permeability of the steel. The only systematic study of the magnitude of this increase that has been published is that by Cole,[13] who found that the increase in hysteresis is approximately a linear function of the gauge. This increase in losses and decrease in permeability may, of course, be corrected by reannealing and this is usually done when the conditions require it.

**Mechanical Condition of Sheets.**

It is of great importance to the user to get sheets which are perfectly flat. Owing to the hardness imparted by the silicon and the deleterious effect of strain in the sheet, the ordinary methods used by the sheet mill for producing flat sheets for automobile or furniture purposes cannot be applied to electrical sheets, nevertheless the sheet must be free from curl and waviness, for such defects seriously interfere with the production of true punchings and the shearing of long strips to the accurate dimensions required for good assembly.

**Scale.**

Freedom from loose or detachable scale is another item of importance to the user. With the higher silicon grades it is not possible to reduce the scale by gas annealing, consequently care must be taken to keep down the amount. Pickling has not been generally adopted in this country, as the scale has a certain value as an insulator between sheets. If too heavy, however, it cuts down the cross section of active material in the core and reduces the efficiency. If the scale is at all loose it becomes a menace, as it may get into the windings of the apparatus and cause a short circuit.

**Testing.**

The Epstein method, as adopted by the American Society for Testing Materials A-34, is now almost universally used as a standard for core loss. This is in reality a standardized transformer with a removable core weighing one kg. (2.2 lb.) built of sheets sheared into strips 50 cm. (19 11/16 in.) by (1 3/16 in.). Permeability tests are made on standard rings or with a permeameter conforming to certain fixed standards.

It is to be noted, however, that invaluable as these tests are as a measure of the quality of the steel, their values, being for definite frequencies and densities, cannot be applied indiscriminately to all classes of electrical apparatus. Variation in density, frequency, and mechanical arrangement, may easily reverse a choice made on the basis of the Epstein test alone.

Just as electricity has become indispensable to our present-day civilization, so silicon steel has become indispensable to the electrical industry.

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[13] G. H. Cole, Elec. Journal, Feb. (1924), p. 55.

## Andrew Glass Dies Suddenly

Andrew Glass, director and vice president-general manager of the Wheeling Steel Corporation, Wheeling, W. Va., died suddenly of heart attack November 21, at the age of 45 years.

With the exception of a period from 1922 to May, 1924, when due to illness he relinguished his duties, he had been in active charge of all operations of Wheeling Steel Corporation plants from the organization of the corporation in 1920 by consolidation of the La Belle Iron Works, Wheeling Steel & Iron Company and the Whitaker-Glessner Company.

Andrew Glass

Mr. Glass was born in Wheeling, received his education in Chicago schools, and held his first position at the age of 18 with the Chicago office of the Wheeling Corrugating Company. In 1909 he became resident manager of the Portsmouth Steel Company, which concern was known later as the Portsmouth Works of the Whitaker-Glessner Company, and subsequently the Wheeling Steel Corporation. Under his direction these plants at Portsmouth, Ohio, were virtually rebuilt.

As general manager of the Portsmouth Works during the World War, Mr. Glass conducted noteworthy experiments for the government and won recognition for his company and for himself for distinguished success in development and production of materials for the Ordnance and Supply departments, and was the personal representative of his company at Washington conferences.

Mr. Glass was a nephew of Alexander Glass, Chairman of the Board of Directors of the Wheeling Steel Corporation, and came of a family of pioneers in the steel industry of the Ohio valley.

# *Removing Scale Mechanically*

## Scraping Billets, Blooms, Bars and Slabs Simplifies the Finishing Operation and Increases Yield

**By FRANK L. ESTEP***

EACH succeeding year the manufacture of steel into various forms brings forcibly to the attention of the steel industry the question of defects in the finished product. In some cases the defects in the metal can be discovered before reaching the stage of finished product, while in many other cases it is not until the final inspection is made and the maximum expenditure has been made for labor, fuel and power, that certain flaws are detected which result in the material being rejected, or being classified under a different grade and sold at a lower price.

Many of the defects which appear at various points during the process of conversion from ingots to finished product can be traced to the metallurgical practice including melting, pouring, the design and condition of moulds, etc. Some may be traced to the soaking pits or re-heating furnaces, and a great many to the rolling. The most common defects are cracks which did not weld, seams, lines, scabs, blisters, slivers and scale, and these are due to the rolling operation.

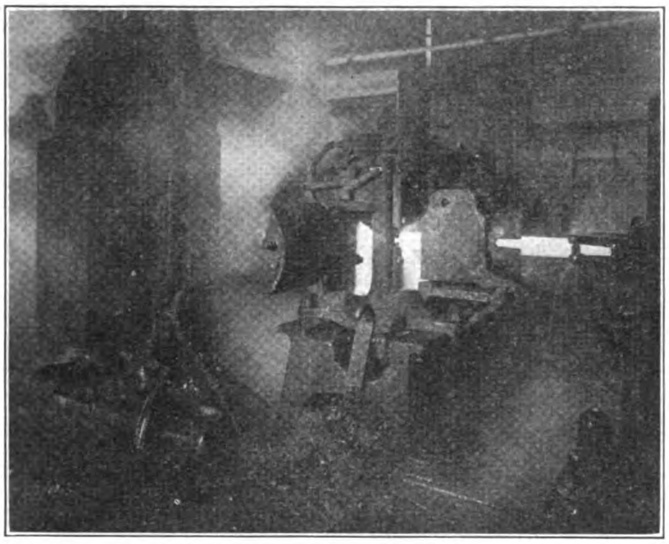

FIG. 1—*Billet Scraper. Scraper shown between No. 3 and No. 4 stands. Size of billet being scraped 2½" square.*

Various methods are used in different plants to overcome many of the troubles arising from defective steel. These include chipping the blooms, billets and slabs to remove cracks, seams and scabs. Various means have been used to remove a part of the scale which arises during the process of rolling. These include the use of water on the steel, chilling to raise scale, flooding at various passes with high pressure water, use of steam, rock salt, etc. In addition, different ways of turning the blooms, billets, etc., have been tried and slabs are set on edge for certain passes to crack off the scale by a slight reduction in area.

For products where the surface is of extreme importance, billets and bars are pickled, and in the case of the manufacture of certain grades of automobile sheets, "breakdowns" are also pickled. In Europe, some of the steel companies are turning ingots in a lathe to remove the outside surface before being heated for piercing and conversion into seamless tubes. The object of this is to facilitate the operations of piercing, pilgering, rolling, drawing, etc., and to increase the yield from ingot to finished product.

If during the rolling of billets scale, slivers and scabs are removed, there will be a material increase in the quality of finished product, and in many cases an increase in the yield of products from billets. Similarly, if during the process of rolling sheet bars for sheets and tin plate, and slabs for hot strip, the top and bottom and edges of the bars are cleaned of heavy scale and scabe and slivers, there will be a marked increase in the quality and surface of finished material, and an increase in yield of finished product from bars.

A scraping device has recently been perfected, whereby billets and bars can thus be cleaned during the process of rolling without reducing the tonnage produced. The results obtained have been most remarkable.

For billets, the scraping device consists of one or two units per billet mill, each unit consisting of two vertical and two horizontal acting knives, the first of which scrapes the billet top and bottom as it leaves the preceding pass, and the second of which scrapes the billet on the sides. The illustration shown in Fig. 1 is between stands three and four of a six stand continuous mill. The size of the billet which is being scraped is 2½ in. square, and the finished size on pass No. 6 is 1¾ in. square. In this particular installation, a second scraper is installed back of pass No. 6.

The cylinder which actuates the knives are operated by air and can be so adapted as to be controlled automatically, closing the knives after the billet enters both sets of knives, and releasing them after the end of the billet has been pulled through. The power required for drawing the billet through the knives is small and is furnished by the rolls. The knives and their holders can be stripped out of the machine between billets during operation without interfering with the tonnage.

For bars, the device consists of two sets of vertical acting knives, one preceding the other by about 9 in. and operated by air as in the case of billets. This can also be made automatic and the knives made to close and open in proper relation to the beginning and end of the sheet bar. For the best results on bars, it has been found necessary to install two scraping units, one either in front of the last pass or next to the last pass, and the other preceding the final scraper by one or two passes. Fig. 2 illustrates the rolling of a sheet bar with the scraper on the entering side of No. 4 stand of a six stand mill, scraping the bar at a thickness of 1-1/16 in., the bar finishing 11.5 per foot in stand No. 6.

The apparatus necessary to scrape the side of the bars is comparatively simple, and in principle is the same as for the top and bottom except that only one set of knives is used. The side scraper is attached to and made an integral part of the second top and bottom scraping unit. In other words, the cleaning of the edges of the bars is done the same time the bar has its last scraping on top and bottom.

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*New York City.

When cleaning billets, if there are slivered places on any corner of the billet, or if there is a projecting fin on the edge of the billet, or as in many cases a rolled-in fin on top or bottom, the scraping knives will as a rule scrape off this projecting material similar to a tool in a lathe. Many of theses slivers, fins, etc., are found in the sweepings after a rolling period.

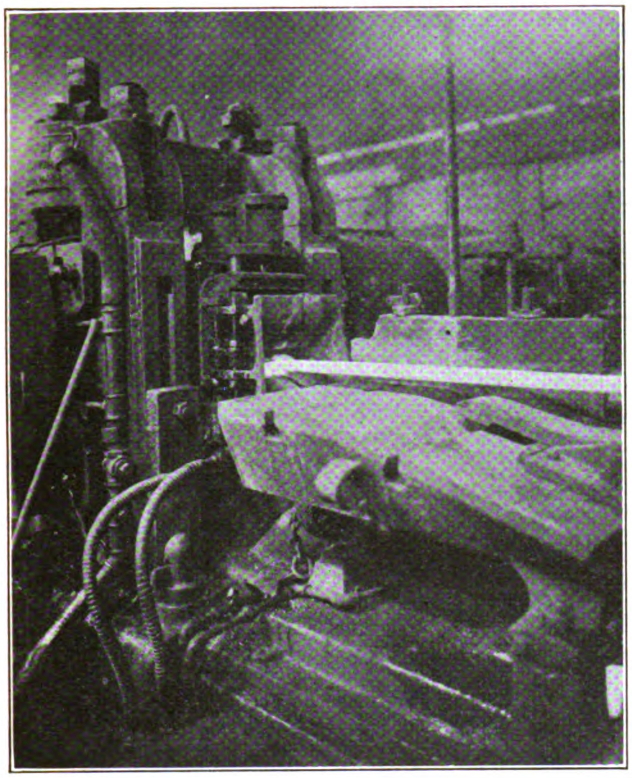

FIG. 2—*Sheet Bar Scraper. Scraper shown on entering side of No. 4 stand. Size of bar being scraped 8" wide x* 1-1/16" *thick, when finished in No.* 6 *stand, weighs* 11.50 *lb. per foot.*

Samples of the scrapings when rolling sheet bar shows a much coarser material for Unit No. 1 than for the succeeding Unit No. 2, and in the sweepings from No. 2 there will be found scabs, slivers and pieces of metal which have been scraped off the edges of the bar.

The knives used for scraping billets and bars are of special steel. No water is necessary on the scraper, and although the knives show color immediately after completing the scraping operation, they have an opportunity to cool and lose their color before coming in contact with the next piece of steel. The knives for bars will scrape 1,000 to 1,500 tons per dressing and the life has been found to have a range of from 12,000 to 15,000 tons production.

The illustrations shown are for the installation of the scraper for both billets and bars on a continuous mill. This type of mill lends itself very readily to apply the standard scraper, but with certain modifications the device can be applied to almost any type of bar mill.

In the plant where the scrapers were first installed, and where they have been in operation for a number of years, there has been a maked improvement in finished material and a decided increase in yield from billets and bars to rods and sheets. The records of the company show that for rods and merchant products there has been an increase in yield of 1.89 per cent after using scraped billets and in the sheet mill department for a period of three years after installation of the scrapers the average increase in yield from bars was 1.50 per cent over a similar period prior to their installation.

## Old Company Establishes New Department

Bell & Gossett Company of Chicago have just announced the establishment of a general industrial instrument department which will pay particular attention to the engineering phases of pyrometer installations. To head this department the company has secured the services of Mr. C. C. McDermott, who is exceptionally well known throughout the industry. Mr. McDermott began his experience with the Brown Instrument Company in their factory at Philadelphia. Later he joined the organization of the Republic Flow Meters Company, where he was in charge of the pyrometer division.

Associated with Mr. McDermott is Mr. R. E. Soules, who has been with the Bell & Gossett Company for several years as a pyrometer specialist.

The company announces that large stocks of complete thermocouples of the various elements commonly used, as well as protecting tubes of the better known materials, will be carried at all times.

## Defective Material and Processes

(Continued form page 472)

steel would spend a day now and again in reheating steel to different stages of burning and submit the burnt samples to different degrees of working. A study of this kind would enable the careful observer to express an opinion about steel which has been more or less burned and subsequently forged or rolled.

To stand at the hammer or rolls and judge the temperature of the material before it is worked is not sufficient. The possibilities of an open coke fire, blast-driven, are well known and it is by no means certain that the reliability of a reverbatory furnace in this respect increases with the complexity of its design or its general economy in fuel. It is consistent with the greatest possible respect for temperature controls and recorders, to suggest that the eye of a good workman or supervisor will be found useful. Why one side of a stamping only is burnt or why only one part of a bar shatters on forging is a problem that one is occasionally confronted with, but a glance at the effects will suggest the cause and usually lead to a remedy.

The main object of this paper is to commend the use of simple means of investigation such as pickling, etching and sulphur printing which require no elaborate apparatus and only a moderate degree of skill. However indispensable the more refined and difficult laboratory operations and apparatus may be, it is undoubtedly desirable to encourage in the factory itself the spirit of inquiry and the use of such means of investigation as are appropriate to factory conditions.

# THE SAFETY CRUSADE

## Tapping the Furnace in Safety

### Increasing Size and Capacity of Blast Furnaces Demands Replacement of Old Fashioned Hand Methods by Modern Mechanical Equipment

By E. B. SPEER*

THE entire blast furnace problem has changed during the last decade. This is the era of the thousand ton furnace. Not so many years ago a blast furnace producing 40 tons of iron in 24 hours, was considered a large furnace, today such is not the case, as there are a number of furnaces producing over 700 tons and not one but several 800 tons in 24 hours with others being rebuilt to exceed that. The steps to this increased production were not so difficult; larger hearths, greater cubical contents of furnace, increased blowing capacity, more heating capacity in stoves and increased equipment of sufficient capacity to handle the increased amount of raw materials, and the iron and slag. This was all accomplished by the expenditure of a greater amount of money for equipment than was necessary on the small furnaces.

There is however one part of a blast furnace and probably the most important from some points of view that has had its work doubled and trebled in some cases.

The tapping hole has not been changed in any important particular although the entire production of these greatly increased capacity furnaces must be

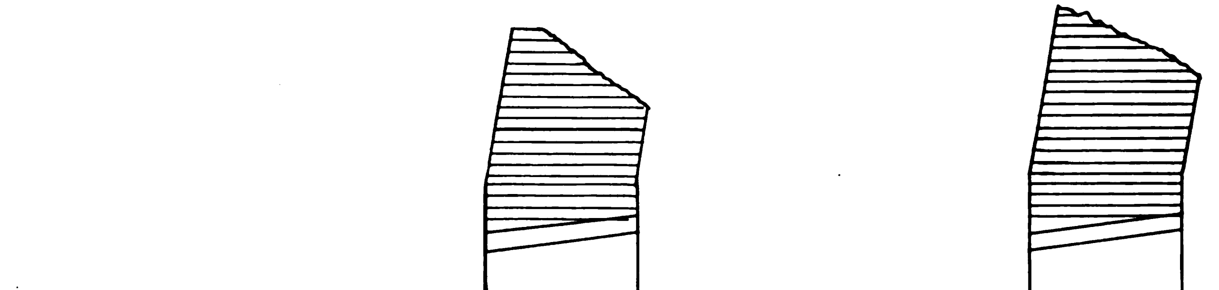

FIG. 1—*The two-cross sectional drawings showing a furnace hearth, indicate the dangerous condition of the refractory lining which may result from improperly drilled tap holes. Break outs occur when this condition has become exaggerated.*

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*Pittsburgh, Pa.

concentrated at this point in its passage from the crucible.

At the iron notch, located from a point above the mantle (this point varying with the ideas of different furnacemen as to how high it is advisable to water cool above the mantle) to a point on about level with cinder notch the preservation of the brick work is accomplished by the use of bronze or copper bosh plates, tuyere coolers and tuyeres and cinder notch coolers intermediates and Monkey. The brick work around the hearth of furnace is cooled by a water cooled hearth jacket or, hearth jacket with a system of cast independent cooling plates, in which pipe coils are cast; these are placed around the inside of the hearth jacket, the outside of these plates being against hearth jacket and the inside against the brick work o hearth of furnaces and extending for some distance below the hearth of furnace.

At and above the cinder notch, where the iron made by the furnace between casts is not supposed to rise, (sufficient space being provided in the hearth below this point for all iron made under normal conditions)it is perfectly safe to use coolers and bosh plates containing a considerable volume of water as they are only exposed to the trickling iron from the melting zone and this is usually not of sufficient volume (even though the plate or cooler is drilled or cut,) to cause a serious explosion, although where pockets of iron have collected around these coolers and cut into the lining as shown in Fig 1 which is a cross-section of the hearth at this point, much damage has been done by the explosion of tuyeres or coolers. Such explosions can be explained by the reasoning that molten iron in large volume is in contact with the iron notch on inside of furnace shortly after cast; it is therefore considered rather risky to use any kind of cooling device containing very great volume of water around the iron notch so the water cooled hearth jacket is brought as near the sides of iron notch as it is thought can be done without danger of cutting; the same is true of the independent cast iron hearth jacet cooling plates when used; some times a hori-

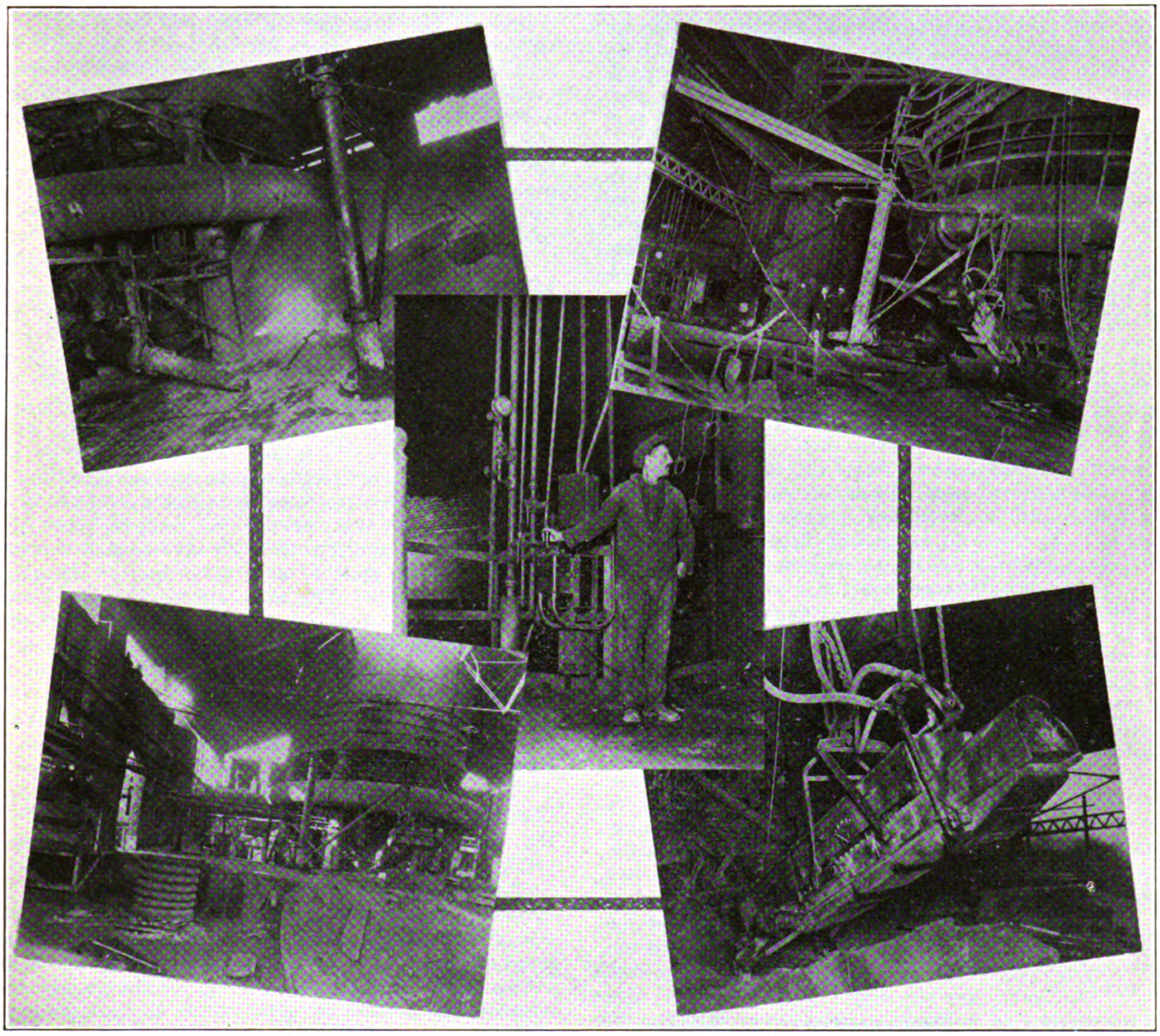


FIG. 2—*Several views showing mechanical tapping during the progress of the operation. Slightly different conditions must be met at different furnaces, but in all cases the remote operator shown in the centre is a feature.*

zontal cast iron cooling plate is used above notch in which pipe coils are cast; frequently these plates last for quite a long time, in some instances have been known to last a whole blast, but this is the exception rather than the rule.

As a general proposition it is safe to say that the iron notch remains as the one part of a blast furnace that can not be effectively cooled without considerable risk, and is the only part of furnace that is called upon not only to withstand the work that other parts of the hearth of furnaces have to withstand in operation between casts, but at casting time in addition, it has to be drilled open every 5 hours, and from 75 tons to 150 tons of iron, and from 15 to 25 tons of slag forced through the entire thickness of hearth wall by the way of a 3 in. to 3½ in. hole, previously drilled to tap the furnace.

The natural tendency of the passage of this amount of highly heated molten iron and slag through the hole is to enlarge it, and that is precisely what happens. To what extent, will depend upon the nature of the refractory material with which the hole was stopped after the previous cast, the kind of iron and slag being produced and the methods employed for the opening of iron notch, the latter having a much greater influence on the strength of the front of furnace, and the resistance of the iron hole to the destructive effect of the flow of iron and slag when casting, than is apparent at first glance.

In the old days when ready to tap the furnace three or four men were placed on each side of the iron trough with a churn drill between them to drill the hole in to the iron notch, the drilling being continued to a point as close to molten iron as safety would permit, as the men were in a rather awkward position standing over the iron trough to get away quickly in the event they drilled through into the molteniron unexpectedly; this sometimes happened with disastrous results tao the drilling gang; usually however, the keeper was able to judge by the "feel" of drill and by looking into hole which was frequently scraped out, whether they had drilled sufficiently close to iron to drive the tapping bar; if so this was done by men with sledges on each side of iron trough; if it was too hard to drive, they continued the drilling operation until such time as the bar could be easily driven; sometimes the bar would get the iron and sometimes not, in such case a dog consisting of a ring and wedge was placed on the bar and removed by sledging it backward, and the drilling operation continued further or other bars were driven until iron was struck.

This method of tapping continued for a number of years until some furnaceman with an ingenous turn of mind conceived the idea of making a long twist drill, and using one of the standard air or electric motors commonly used for drilling metal parts of machinery.

The twist drill method was a distinct advance as this required less labor and was much more satisfactory for the removal of the softer portion of hole than the older method; the operation consists in inserting the twist drill in the motor which is either connected to the power by wires or an air hose; the motor is provided with two opposite handles and a man on each side of iron trough uses these handles to direct the drilling operation; similar to operating a portable drill the men press forward on these handles while the motor is being revolved and they feel out the hole in much the same manner as the drilling gang on a churn drill. Great care and precision are needed to avoid drilling into iron, as iron burns the twist drill which is expensive to make, and there is a possibility of dropping the motor into the running iron as well as the danger of men being burned.

The twist drill is not well adapted to the drilling of hot hard material at it is necessary to keep the drill pressed against the work all the time and it soon becomes so hot that lips on the drill turn over, thus making the drill useless for further work until it is redressed; if at this point they have drilled sufficiently close to iron to drive a tapping bar this is done, if not they continue the drilling with churn drill until they can drive the bar, or if they are close to iron and have iron in hole, three or four lengths of ¼-in. gas pipe are screwed together and connected to a tank of oxygen, this pipe is inserted in iron hole and the oxygen turned on from tank.

When a frozen iron hole exists either through a bad working furnace, or from other causes oxygen is invariably used, as the time consumed with any kind of a drilling tool in drilling through three or four feet of iron is too great, the main object, at a time like this being to get the iron out of the furnace regardless of expense in the quickest possible manner. As a tapping medium on a normal working furnace the cost of the pipes and oxygen consumed, makes tapping by oxygen expensive, and dangerous to the men handling the pipes, as sufficient pressure has to be used to blow the iron from away in front of the oxygen pipe to do effective work, and it is difficult for the men to escape the shower of sparks, and to properly manipulate the oxygen pipes. The use of oxygen under normal conditions is a dual process; first some method of drilling the hole until iron is reached must be used, and then oxygen used for the latter part of the operation.

The foregoing covers the methods employed in the tapping operation at the blast furnace up to the time of introduction of Mullen Tapping Machine.

This machine was designed by an experienced blast furnace operator who was very familiar with the hazards constantly undergone by the tapping crew.

The evident necessities of any machine that would satisfactorily replace hand labor, must be remote control, and staunch reliability, the entire taping operation must be performed by merely positioning a machine in front of the furnace, turning on the power by a controlling operator at some safely distant point and after the cast, removing this machine in safety. The present machine meets these conditions ideally, as reference to figure 2 will show.

Two different installations are pictured. Both show the bosh of a furnace with the tapping machine in position. The view at the lower left emphasizes the absence of men in front of the furnace and shows the single operator at a safe distance; the man shown at the nest of small valves is the operator.

This machine uses a churn drill as this type of drill is better adapted to the drilling of strong holes, and where the material is hot, is in contact with the material but an instant and has opportunity to cool during backward and forward stroke.

The ideal machine was not produced at the initial attempt, but the results convinced the practical furnace men that the effort was in the right direction. Continued operation of machines developed the fact that improvement could be made to advantage in design, materials, and methods of operation. This has been accomplished. The machine as produced today is a simple rugged and dependable piece of apparatus, and is operated by any of the men at the front of the furnace.

The operation is as follows. The machine is placed in front of furnace, in horizontal position, when grips on machine are over the lugs on the iron trough; the operator advances the position of drilling cylinder which balances the front end of machine down over the lugs on the iron trough; the operator then opens a three way valve which admits air to gripping cylinders; this locks the machine in position for tapping operation.

The operator then moves the drilling cylinder to rear end of machine and the drill is inserted in chuck; the operator then starts the drilling cylinder in operation, and feeds the drilling cylinder forward as the feed indicator shows feed is required. When iron is struck the operator releases the grip holding the machine at front of furnace, moves the drilling cylinder to the rear of machine which balances the machine out of grips to a horizontal position and through a three way valve admits air to small cylinder for removal of machine to a point provided for parking.

Thus one man in a safe position with this machine taps the furnace, alone he drills directly through to the molten iron, the hole is perfectly true in bore and a clean hole of the same diameter right through to the iron results in a uniform flow of iron while casting, and an ideal hole for the mud gun to shoot through its first cylinder full of clay.

The keeping of the front in strong condition is due to the fact that the machine once set in proper position always drills the hole exactly through the same hole in hearth well, and thus leaves the brick work in its original strength, excepting the amount cut out by first few casts, when these are replaced with a strong mixture, each cast soon confines the cutting of hearth wall to a limited area around the hole.

The material used to stop hole soon forms a circular layer of burnt hardened material around hole as strong or stronger than the brick work itself.

Since a furnace is no stronger than the weakest spot in its hearth wall, there can be no argument against any method of maintaining the front wall intact. This machine was designed to drill the strong mixture which must be used to re-inforce this hazardous spot. Ordinary apparatus or time-worn methods can not cope with such a problem.

If the Safety Director were asked to prepare a sign to be located and illuminated, constantly on guard at the front of a blast furnace, he could do no better than summarize his recommendations in four paragraphs:

1—Allow no worker in front of the furnace while it is being tapped.

2—Don't use tapping bars — they are unnecessary.

3—Keep the front wall of the furnace and the iron-notch in strong physical condition.

4—Permit no haphazard hand directed tapping methods. Machines guarantee precision.

These four conditions would relieve the department of the heavy responsibilities which have always accompanied failures at this important point.

## Length of Rail Is Increased

As a further step to bring about increased economy in railroad operation, new specifications have been approved by the American Railway Association by which the length of rails used by the railways of this country is to be increased to 39 feet. This means an increase of 6 feet over the rail in present use although the weight per yard will continue to be the same.

By making an increase in the length of the rail, there will be a marked saving to the railroads, not only in the cost of installation of new rail, but also in the maintenance of the railroad track.

This increase in the length of the rail from 33 feet to 39 feet means a reduction of 16 per cent in the number of rail joints while it also will mean a saving of about one-sixth of the total expenditure required for bolts, nuts, joint bars and spring washers used in connecting rails together.

It is estimated that 50 cents out of each dollar spent for track maintenance goes for maintenance of joints, ties and ballast under the point where two rails are joined together. This increase in the length of rail, therefore, will mean a saving of about 16 per cent in such expenditures, as there will be fewer joints.

Surveys have shown that a large number of the breaks and the greatest wear and deterioration in rails occur at the point where they are joined together so that by increasing the length of the rail and reducing the number of such points, the chances for accident due to broken rails are reduced.

In addition, cars passing over a track constructed of longer rails will move more smoothly than over a track where shorter rails are used. This will result in a saving in the wear and tear on railway equipment.

## Railway Safety

How largely safety has been developed for passengers on the railroad lines in this country is shown by the reports for the year 1924, when, with 931,000,000 passengers carried, there were only 149 fatalities, or one life lost for each 6,314,000 passengers served. Railway managers and employees have reason for pride in the showing. It could not have been made without very great care in planning and in operating the passenger trains.

The railway figures are far ahead of those shown in automobile accidents for the same period, as the autos killed 19,999 people and inflicted injuries on about 450,000 others. The railway figures show the results where properties are placed only in safe hands, operated with the greatest care, under constant supervision. The auto toll of life shows the cost of permitting any person to operate a car, with no supervision, no training and no demonstrated fitness shown for the work. While the greater number of autos are in the hands of men and women who are careful in driving them, the few incompetent and reckless drivers do terrible damage to life and property.

# Automatic Arc Furnace Control

## A Description of Modern Automatic Electrode Control for Arc Furnaces Used in Melting

By J. A. SEEDE*

THE different types of electric furnaces require, or permit, the use of various kinds of control. Both manual and automatic control being used practically all furnaces, manual control being used during starting and emergency periods, while automatic control is used during steady operating conditions.

Automatic control may be based on the temperature of charge or resistor at values up to 1,200 deg. C., although this is a rather high figure, a more reasonable one being 1,000 deg. C. Above these temperatures, automatic control is based on power input, careful attention on the part of the operator being necessary to control other factors that prevent successful operation. The power input to resistance furnaces is commonly varied by changing the voltage of the power input, this covering a large field of application in itself, especially in the larger furnaces, while the power input to arc furnaces is varied chiefly by moving the electrodes.

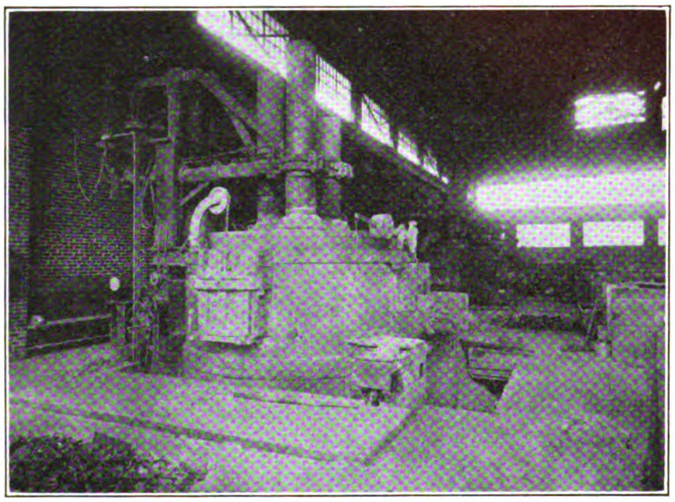
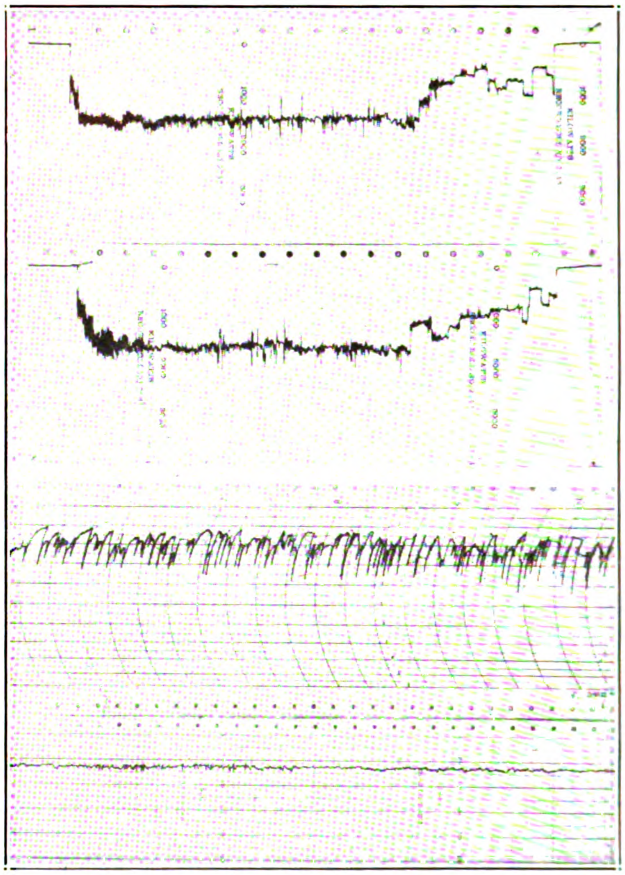


FIG. 1—*View showing the electrode supporting mechanism which must be of exceptionally heavy construction.*

As the electrodes are moved towards the charge, the arc is shortened and more current is taken while, if the electrodes are moved away from the charge, the reverse action takes place. Accordingly, all that is necessary to control an arc furnace is some device responsive to changes in the power supply being furnished, which in turn causes a motor, or other device, to raise and lower the electrodes. As many know, this is not a simple matter and many precautions must be taken to insure service that will be satisfactory to the furnace user and the power company. This type of automatic electrode control is used broadly in two types of furnaces, melting and smelting, the melting furnaces ranging in capacity from 100 kva., single phase, or 3 phase, to 5,000 kva. 3 phase. The smelting furnaces are somewhat larger, ranging in capacity from 500 kva. 3 phase, up to 15,000 kva., 3 phase or 6 phase.

All arc melting furnaces are of the straight arc type, the arc being drawn from the electrode to the metal in the majority of furnaces, such a 3-phase furnaces used to melt steel, and between electrodes above the metal in sigle phase furnaces used to melt non-ferrous metals and alloys, such as brass, bronze, copper, etc. Such furnaces, especially those in which the current arcs to the metal, are difficult to control on starting and, as a heat may be melted every three hours or less, the service demanded of the regulator is severe. The smelting furnaces are of the smothered arc type, in which the electrodes are plunged into the charge. This type of furnace runs continuously for many days and the demands in the controls are moderate, the resultant load being nearly constant.



*Comparative curves showing the results of controlled operation.*

From this it is obvious that control that will successfully take care of a direct arc steel melting furnace will also handle a smoother operating smothered arc type. Consequently the standard automatic electrode control for arc furnaces used in melting steel and iron will be described. As will be seen from Fig. 1, the electrode supporting mechanism and holder must have considerable weight to support the electrode at the end of the arm so that, especially in the larger furnaces, the combined weight of the electrode and its support that must be moved up and down in maintaining the arc current constant, runs into hundreds of pounds and this fact should be borne in mind in considering the duty of the regulator.

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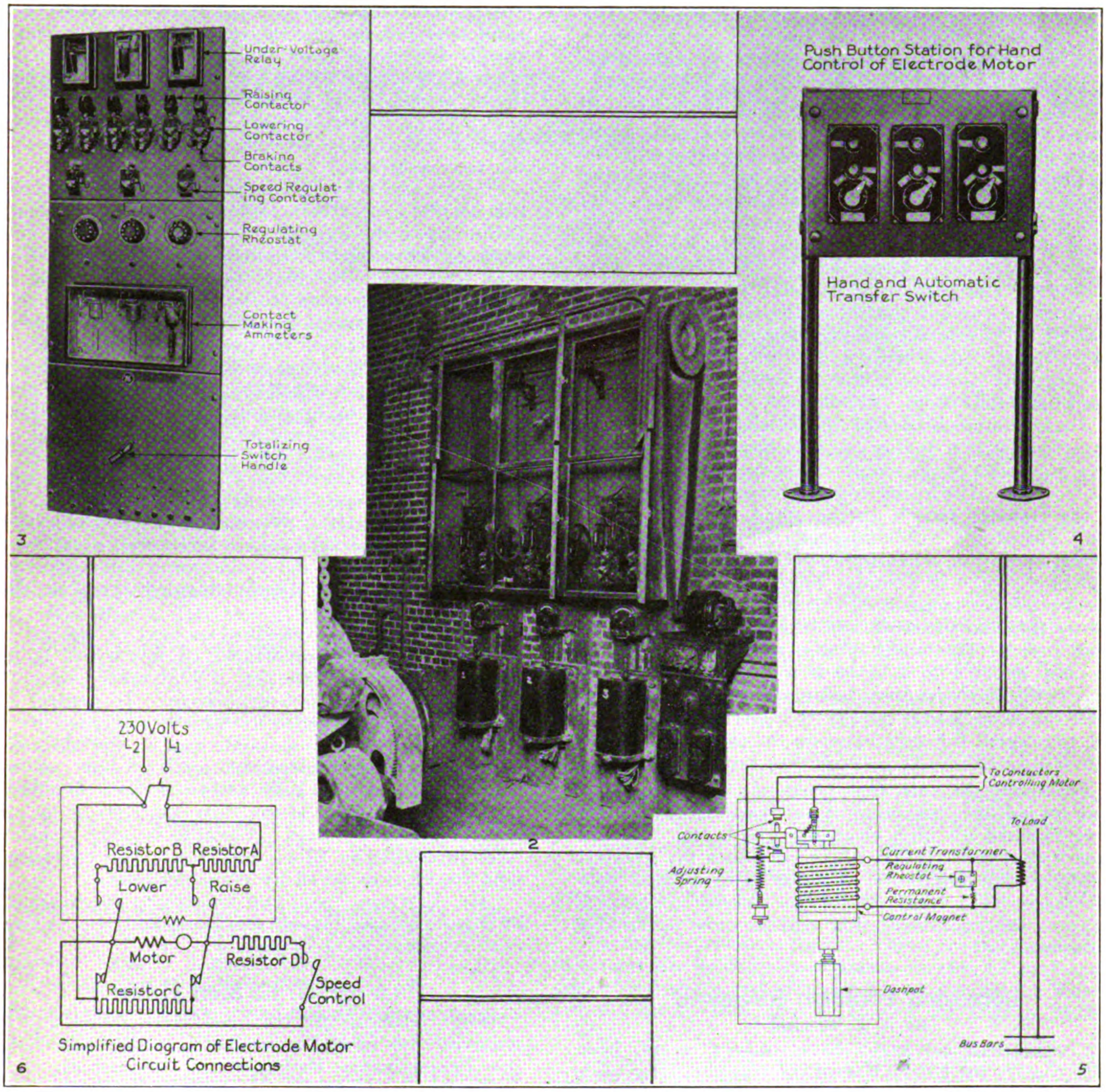

FIG. 2—*The earliest type of automatic electrode control.* FIG. 3—*A modern type automatic control.* FIG. 4—*A push-button station for hand control of elecrode motor.* FIGS. 5 *and* 6—*Wiring combinations upon which the standard control is based.*

Under normal conditions, the arc is approximately 1-in. long, this value depending upon the voltage across the arc and condition of the charge, such as amount and kind of slag, etc. With such a short arc, it is obvious that a change of a small fraction of an inch will mean a considerable change in the current and, consequently, the movement of the electrode must be under positive control. This applies not only to starting the electrode but, in a greater measure, to stopping it; consequently in practically all successful electrode controls, shunt wound motors are used, on account of dynamic braking. The first, and for many years, the only automatic electrode control used with arc furnaces, was the Thury type shown in Fig. 2, this control being based on the theory of moving the electrode to its new position by a series of short movements, approximately 100 per minute, at a rate of 1/16-in. per movement, giving a speed of about 7-in. per minute on the average. The free running speed of the motor gave an electrode speed during hand control of 3 to 4 feet per minute, this figure being the basis of the present G. E. control. It is obvious that a device which causes the motor to start and stop 100 times per minute is subjecting the whole mechanism to excessive mechanical racking and, with the idea of obtaining more reliable operation, the General Electric system of automatic control was designed to move the electrode from its old position to the new position in one movement, instead of a series of steps. After the customary period of development, this device was sold to the furnace companies, in conjunction with transformers, motors and switchboard panels.

The up-to-date regulator is shown in Fig. 3. The small panel in Fig. 4 is the auxiliary or operator's panel, enabling the operator, or melter, to control the electrodes manually or automatically, as he sees fit.

The standard control is based on a combination of figures 5 and 6. All the apparatus on the main panel shown in Fig. 3 is included in these diagrams with the exception of the undervoltage relay and the totalizing switch, whose functions will be explained later. Under normal conditions, the current transformer shown in Fig. 5 would be excited from one of the leads going to the electrodes, a large part of the current being shunted by the regulating rheostat at full load, this permitting a current control in the electrode of about 15-and-1. The contact making ammeter is of standard design, being fitted with a dashpot with adjustable damping, the contacts of the ammeter having a clearance of about 1/16-in.

These contacts control the raising and lowering contactors shown in Fig. 6, this latter diagram giving a good idea of the simplicity of the motor and control circuits. The speed control contactor is operated by the transfer switch on the small panel in Fig. 4, being closed for automatic operation and open for manual operation, when high speed is necessary. The totalizing switch is a simple hand-operated contactor type switch for controlling the input to the electrode motor, the main circuit and the individual circuits being fused. The undervoltage relays at the top of the main panel, Fig. 3, serve two purposes: First, to prevent the lectrodes from being plunged into the bath when the main power supply is interrupted and, second, to prevent the drop between the electrode and the bath falling below 25 volts during normal operation.

From time to time, new types of control or variations on old ones are brought out, various advantages being claimed for high electrode speed, etc., but it is evident that that system which combines the greatest simplicity and reliability, together with a close control, taking into consideration the service conditions, indicates the equipment that will be most acceptable to the user.

## Corrosion Problem Reviewed

By A. C. Blackall

Considerable advances have, of late years, been made toward the elucidation of the troublous engineering problem of corrosion. Some of these were recently outlined by W. S. Patterson, M.Sc., A.I.C., in a paper before the Institute of Marine Engineers in London. The outstanding points in Mr. Patterson's paper are summarized hereunder:

Much of the corrosion trouble is initiated at centers called corrosion cells by definite impurities in metals such as slag inclusions in wrought iron. Impurities which dissolve, giving solid solutions, tend to cause corrosion over a wide area, and this is referred to as wasting, while insoluble impurities due to segregation are more likely to cause pitting and local corrosion. Variations in the stress in metals may cause the development of corrosion cells, and much corrosion may also result from abrasions on the surface of the metal.

The influence of corrosion deposits upon further action may be either to increase or diminish the attack. Deposits are to be regarded as of primary importance in the mechanism of corrosion. If a deposit is impervious to the surrounding electrolyte, it may protect the surface on which it rests. If, on the other hand, it allows the electrolyte to reach the surface, but shields the metal from oxygen, then corrosion may occur as the result of differential aeration. Variations in the conditions of boiler feed and condenser water also play an important part in determining the character of a corrosion deposit, and therefore also affect the rate of attack.

Recent work by Evans has yielded the knowledge that anodic and cathodic zones may be established by variations in the oxygen concentration over a metal surface. Portions of the surface shielded from oxygen may be anodic, the metal therefore undergoing corrosion, while the more freely oxygenated portions are cathodic. The more extensive the cathode and the readier the access of oxygen to it, the greater the corrosive effect centered at the anode area. The bottom of a small pit which may be developed by direct chemical attack or by impurity cells will function as the anode. The surrounding surface to which the oxygen can more readily gain access will become the cathode, and the corrosion will be concentrated inside the pit, which may thus develop very rapidly, with eventual perforation. Water-line corrosion may be regarded as a special case of differential aeration, the highly aerated area above the water line concentrating the attack on an anodic shielded area just above the water line.

These have been classified as acid or neutral. In acid corrosion the importance of impurities is indicated, and where these are of high over-voltage the function of oxygen as a depolarizer. In neutral electrolytes corrosion action is largely governed by the oxygen supply. It is possible that in the absence of oxygen no prolific corrosion would occur in such media. The oxygen may act either as a depolarizer to the cathodic poles of the corrosion cells or by causing differential aeration. Variable velocity of electrolytes in condenser tubes may also cause corrosion, a point to be considered by plant designers.

Mr. Patterson paid full tribute to the researches of Bengough and his collaborators, and also to the recent excellent work of Evans.

## Four G. E. Men Killed

Four General Electric men were killed and two were injured in the train wreck which occurred on the Pennsylvania Railroad near Plainsboro, N. J., November 12. The dead include R. D. Reed, a member of the General Electric industrial department and in charge of the sale of electric arc welding equipment; Mark A. Atuesta and Arthur W. Gross, members of the manufacturing department, and John C. Horstman of the manager's staff at the Schenectady plant. Among the injured were D. H. Deyoe of the Industrial Engineering department of the company and Thomas Wry, of the Lynn River works.

All the men had met in Baltimore in connection with the Inter-works welding committee of the General Electric Company and were en route to the Bloomfield plant when the accident occurred.

# CURRENT REVIEW

## Current Literature on Ferrous Metallurgy

By E. H. McCLELLAND*

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Certain unsolved problems relating to manganese steel. Robert Hadfield. *Chem. & Ind.*, v. 44, Oct. 23, 1925, p. 1042-1044.

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Defective material and processes. Harry Brearley. *Forging*, v. 11, Oct. 1925, p. 375-378.

Defects revealed by pickling, etching and sulphur printing.

Description of the Perlit process. H. J. Young. *Foundry Trade J.*, v. 32, Oct. 8, 1925, p. 294-295.

Discussion Oct. 15, 1925, p. 331-332.

Drawability of sheets and strips. H. S. Marsh and R. S. Cochran. *Iron Age*, v. 116, Nov. 5, 1925, p. 1251-1252.

Electric steel for staybolt use. Thomas S. Wheelwright. *Iron Age*, v. 116, Nov. 5, 1925, p. 1243.

Electrically-produced blackheart malleable. F. A. Melmoth. *Foundry Trade J.*, v. 32, Oct. 15, 1925, p. 325-328.

Handling heavy castings. *Foundry*, v. 53, Oct. 15, 1925, p. 814-817.

Heating steel by the salt bath method. *Iron Trade*, v. 77, Nov. 5, 1925, p. 1148-1149, 1152.

Herstellung verschiedener stahlsorten im Thomaswerk. Erich Faust. *Stahl u. Eisen*, v. 45, Oct. 8, 1925, p. 1701-1704.

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Hold uniform temperature in permanent molds. Pat Dwyer. *Foundry*, v. 53, Oct. 1, 1925, p. 787-790, 798.

Improved foundry tackle. H. V. Fell. *Foundry Trade J.*, v. 32, Oct. 8, 1925, p. 298-300.

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Introduces electrolytic iron to wider usefulness. E. C. Kreutzberg. *Iron Trade*, v. 77, Nov. 12, 1925, p. 1207-1210.

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Large uses of steel in small ways; wood pipe. *Iron Trade*, v. 77, Nov. 12, 1925, p. 1213.

Rods for banding wood-stave pipe.

Lifting magnets for handling pigs and castings. C. H. S. Tupholme. *Foundry Trade J.*, v. 32, Oct. 8, 1925, p. 305-307.

Making seamless tubes by improved process. E. F. Ross. *Iron Trade*, v. 77, Oct. 29, 1925, p. 1079-1083, 1091.

Malleable furnace fired with pulverized coal. Warner Hathaway. *Foundry*, v. 53, Oct. 15, 1925, p. 824-828, 832.

Massnahmen zur begünstigung der indirekten reduktion im hochofen. Konrad Hofmann. *Stahl u. Eisen*, v. 45, Oct. 8, 1925, p. 1709-1711.

Metal molds by a new process. M. S. Clawson. *Iron Age*, v. 116, Nov. 12, 1925, p. 1310-1312.

Metallic corrosion in concentrated phosphoric acid. Fuller Clarkson and H. C. Hetherington. *Chem. and Met.*, v. 32, Oct. 1925, p. 811.

Mixes sand mechanically. Max Sklovsky. *Foundry*, v. 53, Nov. 1, 1925, p. 882-885.

Neuzeitliche gussputzerei. U. Lohse. *Stahl u. Eisen*, v. 45, Oct. 1, 1925, p. 1661-1666.

One of the causes of variations in rates of graphitisation of white cast iron. Anson Hayes and H. E. Flanders. *Foundry Trade J.*, v. 32, Oct. 15, 1925, p. 329.

Opening frozen blast furnace holes. E. E. Thum. *Iron Age*, v. 116, Nov. 5, 1925, p. 1244-1247.

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Saving the gray iron foundry; steps are recommended to protect the industry from encroachments of steel and malleable castings and of forgings and stampings. Richard Moldenke. *Iron Age*, v. 116, Oct. 29, 1925, p. 1165-1167.

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Some fundamental relationships in cast iron, wrought iron and steel manufacture. J. E. Fletcher. *Foundry Trade J.*, v. 32, Oct. 15-22, 1925, p. 321-324, 341-343.

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Time of pouring large ingots. J. H. Hruska. *Iron Age*, v. 116, Nov. 12, 1925, p. 1305-1306.

Traces relation of ferrous metals. I; describes effect of remelting pig iron and structure relation between cast, wrought, malleable iron and steel and the original pig. J. E. Fletcher. *Foundry*, v. 53, Nov. 1, 1925, p. 878-881, 890.

Serial.

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*Technology Librarian, Carnegie Library of Pittsburgh.

## America's Future in the Air

A battle among the great financial interests for control of the country's aerial transportation is freely predicted by several newspapers in view of the recent activities on the part of several great industrialists. This "battle of billions," as one editor phrases it, has aroused both popular and official interest; and we are assured that from now on the development of commercial aviation will be fostered by the government in every possible way.

A tangible indication of America's awakening to the fact that we are a decade behind the world in air development is the entry of big capital into the industry. This forecasts an era of aeronautical development without parallel in this country.

One of the principal obstacles to the development of commercial aviation, says the Wall Street Journal, has been the absence of inclusive Federal regulations governing the air. Capital will venture only timidly, if at all, into an industry whose laws may be radically changed on short notice. Fortunately there are excellent prospects that this condition will soon be remedied. America also has lacked the sharp spur of political fear which drives all European nations to new aerial achievements.

Following the war there was a miniature boom in aviation in this country, based chiefly on public curiosity. Ex-army aviators bought governmental planes at bargain prices, and established themselves in the lucrative business of taking up passengers, at prices ranging from $10 to $25 per trip. For a while these "gypsy" fliers did a land-office business, but eventually public curiosity waned, especially as it became apparent that, owing to lack of proper regulation and inspection, a trip with a "gypsy" flier carried an element of risk out of all proportion to the pleasure received.

In 1922, there were 450 airplanes in operation in this country, which flew more than 2,000,000 miles, and carried 75,268 passengers. Last year the number of planes in active operation had shrunk to 217, which flew less than 1,000,000 miles and carried approximately 49,000 pasengers. The government has disposed of its surplus army planes, and the "gypsy" flier is a fast vanishing race.

Following this initial phase, there was a readjustment of the industry. The activities of airplane manufacturers and operators are now limited to those phases of aviation for which there is a demand. At the present time there are about 60 companies, firms or individuals engaged in operating airplanes, and their activities include carrying passengers, mail and freight, aerial photography, sight-seeing, instruction, crop-saving, observation, forestry patrol, bootlegging, etc. Last year 159,564 pounds of aerial freight were carried, of which 88,500 pounds were mail. The average charge per machine hour was $40, and the average charge per pound mile was .0018 cent.

Commercial aviation seems to be on the brink of a great expansive movement. The Ford Motor Company has formally announced its entry into the field of aviation. At Dearborn, Mich., the Ford interests have established an air port of the first class. Complete services for airplanes and airships have been established, and a mooring mast of improved design has been erected.

The Aircraft Development Corporation, which is the name of the Ford company, proposes to use Stout all-metal planes in their air experimentation work. The new company will at first carry only Ford cargoes between Detroit and Chicago, and later between Detroit and Minneapolis, but there can be little doubt that Mr. Ford intends to develop his new industrial venture into something more ambitious.

The very fact that a man with the resources and manufacturing talent of Henry Ford has interested himself in aeronautics is an exceedingly encouraging sign for the future of the industry. After long and careful experimentation Mr. Ford apparently has decided that the airplane has completely proved its worth as a commercial carrier, and that it will greatly reduce delivery time not only on important parts for motor cars and tractors, but on mail between the Detroit office and the various branches of the Ford company.

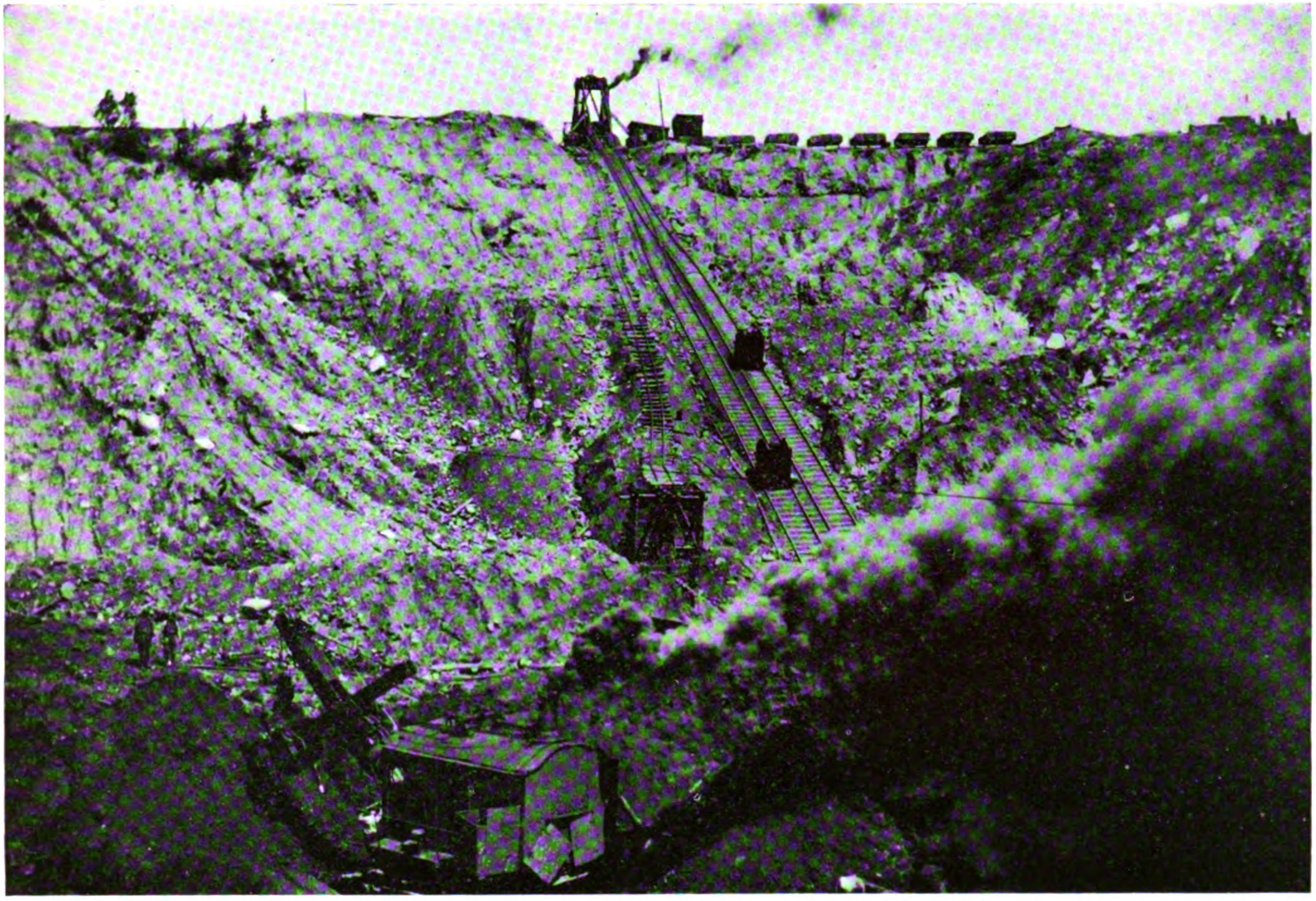
The importance of this development to the public is gradually being realized. Factory experiments in air travel will test the reliability of the machines before the novices will have a chance to risk their necks. Improvements will be forthcoming before the planes go on the market in a general way. Meanwhile the Ford organization will be building up an air equipment of considerable commercial importance. It will give America a start toward the development of a merchant air fleet.

Not only will such a fleet be an invaluable complement to our present transportation facilities, but it will form the backbone of a strong aerial defense in case of war. Commercial aviation bears the same relation to military aviation as the merchant marine does to the Navy; it supplies the pilots and planes needed in war. European and Asiatic nations subsidize their airways for this very reason. It is not likey that democratic America will follow suit, yet the support of the government and the passing of favorable air navigation laws will be absolutely necessary for proper development of America's air fleet.

The rebirth of interest in commercial aviation is fraught with significance for makers of fine alloy steels. United Alloy has contributed its share of developments and discoveries which gave to aviation steels of the required reliability for safe flying. In many a powerful Liberty motor, the carnkshaft has been of U-Loy steel. In vital parts of many makes of planes, U-Loy steels have withstood the terrific strains of high speed flying.

Excess weight is the factor in airplane construction which must be held to a minimum. It may confidently be expected that nothing but the finest alloy steels will be used in the new commercial planes, not only because of their reliability, strength and resistance to shock and fatigue, but also because of the saving in size and weight of parts which they effect.

The integrity of U-Loy steels having been demonstrated in every condition of service, it is to be expected that United Alloy Steel Corporation will play as important a part in the new air development as it has in the development of the motor car to its present degree of perfection.—U-Loy News.



A LARDER FOR IRON SMELTERS
*The installation of incline-skips and scrapers has resulted in an unusually efficient method of mining ore at the Miller Mine of the Pitt Iron Company.*

# A Unique Method of Iron Mining

## Instead of Locomotives and Cars, a Scraper and Raises Are Used at the Miller Mine, Pitt Iron Mining Company, on the Mesabi Range

**By J. R. St. CLAIR, in Explosives Engineer**

PRODUCTION has been hastened and a saving of time and money realized through the installation of the scraper system of tramming iron ore to the raise, on the stripping operations at the Miller Mine, of the Pitt Iron Mining Company, on the Mesabi Range, Aurora, Minn. By using the scraper, the constant changing of track and the expense involved in the operation of dinkies or small locomotives and dump cars is eliminated.

This stripping is taking place in a small area which was the sustaining pillar for an abandoned underground shaft. The ore body lies on a 25 degree dip and the maximum thickness to the south is approximately 80 feet. The elements that entered into the decision of this company to employ the scraper system were the following physical conditions surrounding the ore deposit; the steep dip, and the fact that the top 25 feet of the deposit consists of so-called paint rock, presenting a difficult mixing problem with the lower ores. The scraper makes its own road bed and is quite easily changed from one position to another when various grades of ore are desired.

THE MEN AT THE WHEEL
*Jim Prowse, pit foreman, and George Gandsey, mining captain, are the solvers of the practical problems of operation.*

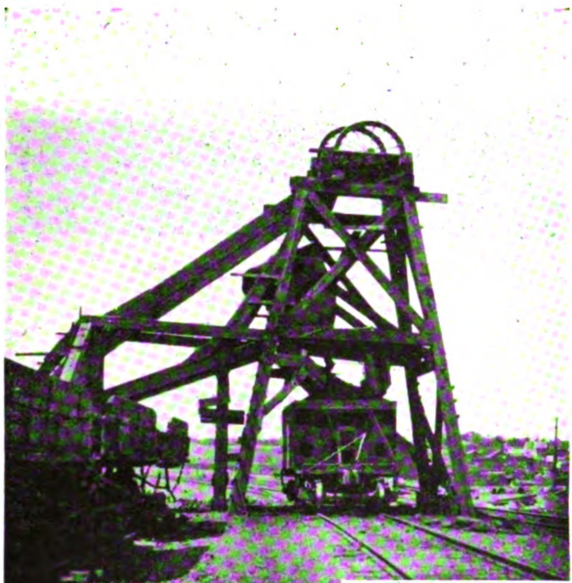
The deposit at the Miller Mine was formerly developed for underground mining and the old drifts and openings make the mining of the ore no easier. In order to evade old openings, blast holes which are well-drilled must be

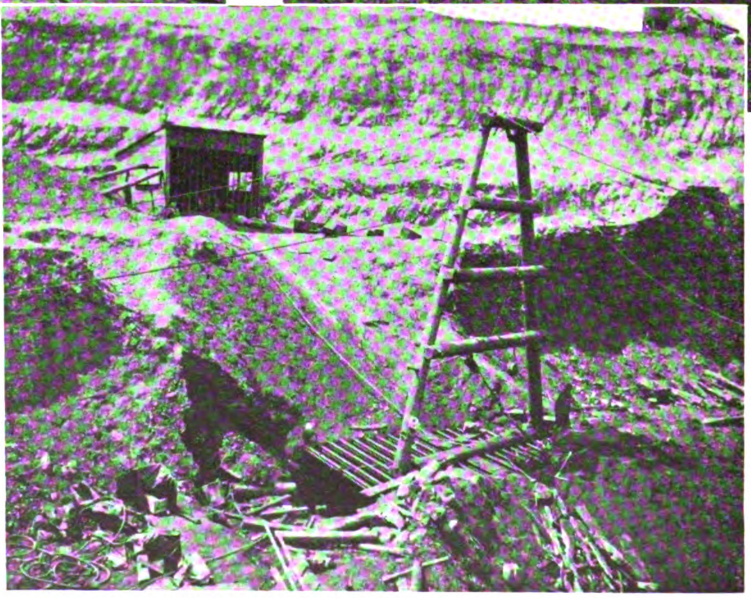
THE BEGINNING AND THE END OF THE INCLINE

*The above view is of the Miller mine. Ore is hauled up the incline from the bottom of the raise and dumped into railroad cars shown below.*

THE RAISE "GRIZZLEY"

*The two-ton capacity scraper can be shifted from the hoist itself, by cables attached to a tail block.*





AT THE HEART OF THE SYSTEM

*A 75-hp., 2,200-v. Sauerman slusher is used to pull the 1,100 lb. scraper.*

carefully placed and the amounts of the explosives charges depend upon the proximity of these holes to the openings. The ore that occurs here is of very hard structure, which is typical of the eastern Mesabi Range, especially where the ore lies close to the local Taconite footwall.

The first operation in removing the ore deposit is to blast the bank down with black powder. The ore is placed to one side by a Marion 36 steam shovel and the scraper then takes it to a 35-foot raise. The ore is dumped and goes through the raise, finding its way eventually into skips of 7-ton capacity.

These skips are hauled up the incline and dumped directly into railroad cars. It is estimated that nearly half of the ore body can be milled into this one raise.

## $4,847,700,000 Paid Last Year by Railroads for Wages, Materials, Supplies, Etc.

Expenditures made by Class I railroads in 1924 for wages, materials and supplies and for improvements totaled $4,847,700,000, according to reports for the year received by the Bureau of Railway Economics from the railroads of this country.

A large part of this sum went directly to the industries of the United States through which source it reached the wage earners, contributing, to a large extent, to the prosperity of the nation. The principal expenditures of the Class I railroads in 1924 were divided as follows:

| | |
|---|---|
| Wages paid for maintenance and operation | $2,629,902,000 |
| Materials purchased, including fuel | 1,343,055,000 |
| Capital expenditures (including new equipment and improvements) | 874,743,000 |
| Total | $4,847,700,000 |

This amount, however, does not include approximately $340,000,000 paid in taxes by the railroads, or an average of $929,000 per day compared with a daily average of $909,000 in 1923. It also does not include $510,000,000 paid out in interest charges by the Class I carriers or $310,000,000 paid out in dividends.

The total principal expenditures of the railroads in 1924 was a decrease of $735,400,000 compared with 1923.

Of the total amount, the railroads paid out $2,629,902,000 in wages for operation and maintenance work during the year while capital expenditures, including new equipment and improvements, totaled $874,743,000.

### $395,648,000 Saved in Fuel and Supplies.

Fuel as well as materials and supplies cost the railroads $1,343,055,000 in 1924, a decrease of $395,648,000 or 23 per cent compared with 1923. This decrease under the year before resulted in part from the fact that the railroads purchased less materials in 1924 than in 1923 due to the somewhat smaller programs for maintenance and additions and betterments on one hand while some of the stocks in storage were drawn upon heavily during the year.

At the same time greater efficiency in operation played no small part in reducing the consumption of train and engine supplies. Declines in the unit cost of many materials during 1924, particularly bituminous coal, the largest single item purchased by the railroads, also had the effect of reducing the amount of expenditures.

Fuel during 1924 cost the railroads $471,656,000, a decrease of nearly 24 per cent under the year before. This decrease was brought about through a reduction in the actual number of units purchased due to greater conservation in the use of coal as well as the fact there was a decrease of 6 per cent in the volume of freight traffic moved during the past year compared with 1923.

Bituminous coal alone cost the railroads $373,483,000 in 1924, a total of 126,372,000 net tons having been purchased, compared with $519,007,000 which was paid for 154,902,000 tons in 1923. Thus while 18 per cent less tons were purchased during 1924 than the year before the total outlay was 28 per cent less.

The outlay for anthracite coal in 1924 was $14,497,000 or 20 per cent less than in 1923, while only about 7 per cent fewer tons were purchased.

Class I railroads in 1924 purchased approximately 26 per cent of the total bituminous coal production of the United States and 5.2 per cent of the anthracite production.

### $111,442,000 for Cross Ties.

The railroads in 1924 expended $180,872,000 for forest products, a reduction of 22 per cent under the year before. Of that amount, $111,442,000 was spent for cross ties, 11 per cent less than in 1923, while 14 per cent fewer ties were purchased during the past year compared with the year before.

More than 27 per cent of the total steel production of the United States was purchased directly by the railroads or for them through equipment manufacturers in 1924. Total expenditure for iron and steel products made direct by the railroads during the year was $365,610,000. This was 21 per cent less than the expenditure for that purpose in 1923. In tonnage, the railroads purchased nearly 21 per cent less than the year before.

Approximately 2,210,800 barrels of cement were bought directly by the railroads during the past year, 8.5 per cent less than the year before. The total purchase price in 1924 was $5,141,000 or 16 per cent less than 1923. This does not include, however, direct purchases made by contractors engaged in railway construction work.

Approximately 14,265,000 cubic yards of ballast were purchased in 1924 at a cost of $12,608,000. As many carriers maintain their own gravel pits and quarries where they meet their requirements for ballast without purchasing in the open market, the quantity recorded as purchased in 1924 is considerably less than is utilized by them each year for maintenance and construction work.

Lubricating oil and grease cost $13,158,000 during the past year, a decrease of $2,520,000 compared with the year before while for brass, copper, zinc and various non-ferrous metal products needed in railway operation, the railroads spent $39,049,000, 32 per cent less than was spent on the same account in 1923.

—Rail Road Data.

## Chemical Bibliographies

A Bibliography of Bibliographies on Chemistry and Chemical Technology, 1900-1924, by Clarence J. West and D. D. Berolzeimer, is announced by the National Research Council, Washington, D. C., as their Bulletin No. 50 (308 p., $2.50). This work is composed of the following sections: General Bibliographies, Abstract Journals and Year-Books, General Indexes of Serials, Bibliographies of Special Subjects and Personal Bibliographies. As the title indicates, the work is a compilation of bibliographies published as separates, or at the end of books or magazine articles, or as footnotes to the same, on the numerous aspects of pure and applied chemistry. Each entry gives name of author or compiler, title, and place of publication. The majority of the entries state the number of references, thus giving an indication of the completeness of the particular bibliography. The entries are classified under the proper subject headings, alphabetically arranged. The duplication of individual entries has been largely avoided by the liberal use of cross-references. An approximate analysis shows that there are about 2,400 subject headings, 7,500 author entries and a total of 10,000 individual bibliographies.

# Analyses of Basic Electric Furnace Steel and Furnace Materials in Europe

**By JOHN HRUSKA**

CHEMICAL and mechanical analyses may be collected and grouped for purposes of record and of comparison. For the first purpose it is desirable that all known analyses of the substances under consideration be collected, for the second, only those known to be complete and reliable are needed. A combination of these two purposes may perhaps be gained, however, by collecting all analyses and leaving to the judgment of the steelworks, foundries, or forges the selection of those suited for the study of any particular phase of the subject.

This plan is practically that which has been adopted in presenting the analyses here collected. In many cases obviously incomplete analyses are given because they represent the most important parts of the chemical constitution of the material used and produced or because they mark a stage in its study. On the other hand, analyses which amount to little more than a qualitative determination in the presence of some chemical elements or compounds, are omitted.

About 100 analyses are here included and it is believed that they comprise practically all of importance in European electric steel-making.

TABLE I.—ANALYSES OF STEELS

1. Carbon Steels—(a) Ingots.

| | | | Analysis | | |
|---|---|---|---|---|---|
| Used for | C | Mn | Si | P | S |
| Sheets | 0.05 | 0.34 | 0.01 | 0.018 | 0.012 |
| R. R. Car wheel centers | 0.24 | 0.65 | 0.24 | 0.016 | 0.011 |
| Axles | 0.38 | 0.48 | 0.22 | 0.016 | 0.012 |
| Plates | 0.39 | 0.53 | 0.26 | 0.022 | 0.010 |
| Tires (R. R. car wheels) | 0.59 | 0.77 | 0.19 | 0.014 | 0.006 |
| Scythes | 0.62 | 0.52 | 0.21 | 0.013 | 0.008 |
| Saws (band) | 0.74 | 0.68 | 0.24 | 0.018 | 0.011 |
| Tools (drills) | 0.86 | 0.64 | 0.26 | 0.021 | 0.014 |
| Dies for thread cutting | 1.13 | 0.46 | 0.25 | 0.016 | 0.007 |
| Saws for cutting iron and steel | 1.53 | 0.72 | 0.28 | 0.018 | 0.004 |

(b) Castings

| | | | Analysis | | |
|---|---|---|---|---|---|
| Castings | C | Mn | Si | P | S |
| *Locomotive driving wheel | 0.19 | 0.69 | 0.36 | 0.022 | 0.021 |
| Locomotive driving centers | 0.22 | 0.71 | 0.33 | 0.018 | 0.015 |
| Flywheel | 0.24 | 0.82 | 0.38 | 0.019 | 0.009 |
| †Stempost | 0.31 | 0.78 | 0.38 | 0.037 | 0.022 |
| Cover | 0.35 | 0.92 | 0.40 | 0.022 | 0.010 |
| Gear | 0.37 | 0.90 | 0.34 | 0.026 | 0.020 |
| Gear | 0.44 | 0.71 | 0.39 | 0.018 | 0.018 |
| Housing | 0.38 | 0.77 | 0.37 | 0.017 | 0.015 |
| Cylinder and top head for hydraulic press | 0.38 | 0.91 | 0.31 | 0.012 | 0.010 |
| Annealing pot | 0.40 | 0.73 | 0.34 | 0.020 | 0.016 |
| Pinion | 0.40 | 0.83 | 0.36 | 0.015 | 0.014 |
| Frame | 0.44 | 0.68 | 0.39 | 0.025 | 0.021 |
| Car wheels | 0.55 | 0.49 | 0.30 | 0.021 | 0.018 |
| Railroad switches | 0.82 | 0.94 | 0.42 | 0.020 | 0.019 |
| Valve body | 0.91 | 0.98 | 0.28 | 0.016 | 0.010 |

*Weight 2,800 lbs. †Weight 14,480 lbs.

2. ALLOY STEELS

(a) INGOTS

| | | | | | Analysis | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Name | C | Mn | Si | P | S | Ni | Cr | W | V |
| Manganese Steel | 1.02 | 13.27 | 0.40 | 0.046 | 0.013 | ..... | .... | .... | .... |
| *Manganese Steel | 0.99 | 12.69 | 0.43 | 0.039 | 0.017 | ..... | .... | .... | .... |
| Silicon Steel (springs) | 0.47 | 0.53 | 1.94 | 0.017 | 0.011 | ..... | .... | .... | .... |
| Silicon Steel (springs) | 0.44 | 0.56 | 1.86 | 0.012 | 0.010 | ..... | .... | .... | .... |
| Silicon Steel (dynamo steel) | 0.28 | 0.43 | 4.46 | 0.016 | 0.009 | ..... | .... | .... | .... |
| Nickel Steel | 0.66 | 0.78 | 0.28 | 0.023 | 0.018 | 0.30 | 0.03 | .... | .... |
| Nickel-Chromium Steels | 0.42 | 0.49 | 0.26 | 0.004 | 0.009 | 1.36 | 0.54 | .... | .... |
| Nickel-Chromium Steels | 0.48 | 0.74 | 0.28 | 0.006 | 0.007 | 2.68 | 0.92 | .... | .... |
| Nickel-Chromium Steels | 0.12 | 0.62 | 0.23 | 0.008 | 0.003 | 3.48 | 1.04 | .... | .... |
| Nickel-Chromium Steels | 0.29 | 0.58 | 0.35 | 0.009 | 0.012 | 23.82 | 2.68 | .... | .... |
| Nickel-Chromium Steels | 0.54 | 0.68 | 0.28 | 0.011 | 0.009 | 24.21 | 2.48 | .... | .... |
| Nickel-Chromium Steels (tires) | 0.41 | 0.48 | 0.23 | 0.009 | 0.007 | 2.08 | 1.02 | .... | .... |
| Silico-Manganese Steel (springs) | 0.54 | 1.24 | 1.38 | 0.008 | 0.003 | ..... | .... | .... | .... |
| Chrome-Vanadium Steel | 0.37 | 0.43 | 0.24 | 0.011 | 0.007 | ..... | 1.04 | .... | 0.23 |
| Tungsten Steel (gun) | 0.65 | 0.29 | 0.30 | 0.008 | 0.004 | 0.38 | .... | 1.21 | .... |

*Specific gravity: 7.887 (forged.

(b) CASTINGS

| | | | | | Analysis | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Name | C | Mn | Si | P | S | Ni | Cr | W | |
| Manganese Steel (R. R. crossings) | 1.09 | 12.32 | 0.41 | 0.042 | 0.012 | ..... | .... | .... | .... |
| Manganese Steel (Jaw of rock crusher) | 1.01 | 13.09 | 0.40 | 0.038 | 0.011 | ..... | .... | .... | .... |
| Nickel Steel (gun yoke) | 0.38 | 0.67 | 0.28 | 0.011 | 0.008 | 2.73 | .... | .... | .... |
| Nickel Steel (stem post for submarine) | 0.24 | 0.74 | 0.34 | 0.019 | 0.013 | 0.44 | .... | .... | .... |
| Chromium Steel (plate) | 0.75 | 0.84 | 0.28 | 0.014 | 0.012 | ..... | 0.48 | .... | .... |
| Chromium Steel (roll) | 0.68 | 0.36 | 0.38 | 0.015 | 0.014 | ..... | 2.09 | .... | .... |
| Nickel-Chromium Steel (plate) | 0.18 | 0.74 | 0.29 | 0.016 | 0.008 | 3.18 | 0.68 | .... | .... |
| Tungsten-Chromium Steel (roll) | 0.66 | 0.90 | 0.46 | 0.024 | 0.013 | 0.39 | 1.30 | 0.28 | .... |
| Tungsten-Chromium Steel (roll) | 0.31 | 0.98 | 0.22 | 0.018 | 0.011 | 0.48 | 0.46 | 0.14 | .... |

(c) ALLOYS FOR SPECIAL PURPOSES

| | | | | | Analysis | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Name | C | Mn | Si | P | S | Ni | Cr | W | Al |
| Heat-resistant Alloy (casting) | 0.38 | 0.62 | 0.34 | 0.018 | 0.012 | ..... | ..... | .... | 14.78 |
| Magnets (rolled) | 0.54 | 0.28 | 0.21 | 0.014 | 0.008 | ..... | ..... | 5.42 | ..... |
| *Stainless Steel (forged) | 0.38 | 0.36 | 0.14 | 0.018 | 0.012 | 0.13 | 11.41 | .... | ..... |
| Tool-steel (forged) | 0.68 | 0.29 | 0.22 | 0.016 | 0.010 | 0.09 | 4.04 | .... | 0.78 |

*Specific gravity: 7.673.

TABLE II.—COMPOSITION OF BASIC ELECTRIC-FURNACE SLAGS

| | Analysis | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Oxidizing Slags— | $SiO_2$ | FeO | MnO | $Al_2O_3$ | CoO | MgO | $P_2O_5$ | $CaF_2$ |
| Carbon Steel | 14.97 | 31.12 | 12.77 | 1.34 | 25.95 | 10.91 | 2.00 | ..... |
| *Chromium-Nickel Steel | 15.68 | 19.68 | 7.88 | ..... | ..... | ..... | ..... | ..... |
| †Manganese Steel | 11.04 | 26.67 | 24.32 | ..... | 24.52 | ..... | ..... | ..... |
| ‡Manganese Steel | 8.68 | 24.38 | 22.39 | ..... | 32.48 | ..... | ..... | ..... |
| Final Slags— | | | | | | | | |
| Carbon Steel | 26.50 | 1.08 | 2.16 | 0.63 | 58.03 | 11.30 | ..... | ..... |
| Carbon Steel | 20.25 | 1.50 | 1.54 | 0.67 | 49.87 | 5.53 | ..... | 20.08 |
| Manganese Steel | 25.06 | 2.10 | 1.31 | ..... | 55.51 | ..... | ..... | ..... |
| §Chromium-Nickel Steel | 24.72 | 0.43 | 0.48 | ..... | 56.28 | ..... | ..... | ..... |
| ¶Tungsten Steel | 23.48 | 0.94 | 0.97 | ..... | 53.11 | ..... | ..... | ..... |

*Steel: 2.5% Ni, 1.0% Cr. †Steel: 13% Mn. ‡Steel: 12% Mn. §Steel: 2.5% Ni., 1.0% Cr. ¶Steel: 1.2 W.

TABLE III.—USUAL COMPOSITION OF THE ADDITIONS

1. FERRO ALLOYS

| | Analysis | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | C | Mn | Si | P | S | Cr | W | N |
| Spiegeleisen | 4.31 | 22.62 | 3.58 | 0.12 | 0.011 | ..... | ..... | ..... |
| Spiegeleisen | 5.08 | 20.46 | 1.06 | 0.26 | 0.010 | ..... | ..... | ..... |
| Silico-spiegel | 1.14 | 18.28 | 23.48 | 0.09 | 0.014 | ..... | ..... | ..... |
| Ferro-Silicon | 0.12 | ..... | 47.86 | ..... | ..... | ..... | ..... | ..... |
| | | | | | | | $H_2O$ | |
| *Ferro-Silicon | 0.17 | ..... | 79.64 | ..... | ..... | ..... | 1.52 | ..... |
| Ferro-Manganese | 6.16 | 72.08 | 5.98 | 0.18 | ..... | ..... | ..... | ..... |
| †Ferro-Manganese | 6.30 | 81.09 | 0.68 | 0.034 | ..... | ..... | ..... | ..... |
| Ferro-Manganese | 5.21 | 53.68 | 6.12 | 0.12 | ..... | ..... | ..... | ..... |
| Ferro-Chromium | 7.73 | 3.92 | 1.60 | ..... | ..... | 49.42 | ..... | 0.02 |
| Ferro-Chromium | 0.64 | ..... | ..... | ..... | ..... | 62.27 | ..... | 0.03 |
| Ferro-Chromium | 5.62 | ..... | ..... | ..... | ..... | 64.83 | ..... | 0.03 |
| Ferro-Tungsten | 0.96 | ..... | ..... | ..... | ..... | ..... | 86.22 | ..... |
| Ferro-Tungsten | 1.08 | ..... | ..... | ..... | ..... | ..... | 85.12 | ..... |

*Used: For reduction. †Used: Mn steel.

2. NON-FERROUS ADDITIONS

| | Analysis | | | | | |
|---|---|---|---|---|---|---|
| | C | Ash | $H_2O$ | Fe | | |
| Coke | 85.79 | 12.96 | 1.20 | ..... | ..... | ..... |
| Coke | 69.81 | 29.04 | 1.14 | ..... | ..... | ..... |
| Carburite | 64.24 | ..... | 0.89 | 30.10 | ..... | ..... |
| | $SiO_2$ | CaO | MgO | $Al_2O_3$ | $Fe_2O_3$ | $CaF_2$ |
| Lime | 0.12 | 93.43 | 0.80 | 0.12 | 0.42 | ..... |
| Lime | 0.16 | 89.64 | 0.67 | ..... | 0.38 | ..... |
| Sand | 97.20 | ..... | ..... | 1.40 | 1.86 | ..... |
| Sand | 98.30 | ..... | ..... | 0.84 | 1.30 | ..... |
| Fluorspar | ..... | ..... | ..... | ..... | ..... | 86.41 |
| Fluorspar | ..... | ..... | ..... | ..... | ..... | 55.94 |

TABLE IV.—REFRACTORIES.

(Analysis of furnace and ladle materials.)

| | | Analysis | | | | | |
|---|---|---|---|---|---|---|---|
| Used for | Name | $SiO_2$ | $Fe_2O_3$ | $Al_2O_3$ | CaO | MgO | Melting Point deg. C. |
| Walls | Magnesite (Czechoslovakian) | 3.32 | 6.12 | 2.00 | 4.17 | 84.79 | .... |
| | Megnesite (Austrian) | 3.82 | 3.64 | 0.83 | 5.35 | 86.90 | .... |
| Hearth | Crushed Magnesite (Czechoslovakian) | 3.07 | 6.22 | 2.53 | 2.12 | 86.04 | .... |
| Roof | Silica bricks | 74.66 | 2.02 | 17.79 | 2.73 | 1.78 | .... |
| | *Silica bricks | 55.20 | 2.83 | 40.38 | 0.69 | 0.29 | 1720 |
| Ladle | †Silica bricks | 56.42 | 3.42 | 39.93 | ..... | 0.27 | 1690 |
| | †Silica bricks | 56.38 | 3.24 | 39.98 | ..... | 0.31 | 1720 |
| Hearth (repaired with) | ‡Dolomite | 4.48 | 6.20 | 1.70 | 56.90 | 29.52 | .... |
| | §Dolomite | ..... | 6.82 | 1.04 | 24.23 | 55.18 | .... |
| | Magnesite-dolomite | 4.39 | 6.90 | 1.36 | 14.42 | 70.60 | .... |

*Life: 40-120 heats (alloy steels). †Life: 20-40 heats (10 ton ladle. ‡4.38% $CO_2$. §4.12% $CO_2$.

TABLE V.—MISCELLANEOUS.

1. FIRST METAL TESTS

(Scrap melted, under oxidizing slag).

| | Analysis | | | | | |
|---|---|---|---|---|---|---|
| Heat | C | Mn | Si | P | S | Ni |
| Carbon Steel | 0.04 | 0.25 | 0.01 | 0.019 | 0.018 | .... |
| Nicel-Chromium Steel | 0.08 | 0.17 | 0.01 | 0.005 | 0.031 | 2.53 |
| Manganese Steel | 0.06 | 0.41 | 0.02 | 0.004 | 0.019 | .... |
| Tungsten Steel | 0.05 | 0.32 | 0.01 | 0.002 | 0.014 | .... |

2. VOLATILE DUST FROM ELECTRIC FURNACE

(Temperature about 130 deg. C.)

| $SiO_2$ | $Fe_2O_3$ | $Al_2O_3$ | MnO | CaO | MgO | $P_2O_5$ |
|---|---|---|---|---|---|---|
| 12.90 | 16.24 | 15.61 | 5.95 | 24.50 | 17.30 | 0.02 |

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## Automatic Magazine Feed for Inclinable Presses

An automatic magazine feed for presses which are fed in an inclined position and which is claimed to eliminate the hazards connected with hand feeding of forming die work, has been added to the line of the F. J. Littell Machine Company, 4125 Ravenswood Avenue, Chicago. Material increase of production is also claimed, due to the feed catching every stroke of the press. The feed can be operated at the rate of 70 to 75 pieces per minute, at which rate the capacity for a 9-hour day would be approximately 30,000 pieces, which is pointed out as being two or three times' faster than by hand feeding. A long stroke is used with this feed so that work is pushed from the magazine directly to the die without stopping at intermediate stations. One piece does not push another piece ahead of it. If a blank should lock in the magazine, a spring pin is unlatched which stops the magazine from feeding, which prevents breakage of the parts.

After the forming operation, the work is lifted out of the die either by the punch or blown out by air. It is stated that in most cases it is better to lift the work with the punch, using the bar knock-out in the slide for pushing the piece off the punch and then blowing it clear with air. Magazines and pushers of various shapes can be used with the automatic feed, making it adaptable to feeding a wide range of forming work.

# The Reaction Between Manganese and Iron Sulfide*

By C. H. HERTY, JR.† and O. S. TRUE‡

IT is well known that manganese will desulfurize molten iron through the formation of manganese sulfide, which being only slightly soluble in the metal, rises to and enters the slag where it remains as such (mixer slag) or is converted partly or wholly to calcium sulfide (basic open-hearth slag). The reaction by which manganese sulfide is formed is $Mn + FeS = MnS + Fe$. This reaction is generally considered to be reversible, although McCance[1] states that such is not the case. The experimental work was carried out to confirm the results of Röhl[2] as to the reversibility of the reaction.

Six trials are herein considered. In each 200 grams of electrolytic iron free from manganese and sulfur were melted in a pure zirconia crucible in a carbon resistance electric furnace. To the melted iron in runs, 2, 3 and 4 metallic manganese and manganese sulfide were added to give 1, 2 and 4 per cent manganese respectively, with 0.50 per cent of sulfur in each. In runs 5, 6 and 7, metallic manganese and iron sulfiide to give the same proportions of manganese and sulphur as in runs 2, 3 and 4, were added. The melts were held molten in the furnace for an hour and then cast into small ingots.

The results of these melts are as follows:

| Run | Material Charged | Ingredients of Manganese, Per Cent | Charge Sulfur, Per Cent | Analysis of Manganese, Per Cent | Ingot Sulfur, Per Cent |
|---|---|---|---|---|---|
| 2 | MnS + Mn | 1.0 | 0.452 | 0.636 | 0.367 |
| 3 | MnS + Mn | 2.0 | 0.50 | 1.57 | 0.310 |
| 4 | MnS + Mn | 4.0 | 0.50 | 2.81 | 0.230 |
| 5 | FeS + Mn | 1.0 | 0.50 | 0.647 | 0.397 |
| 6 | FeS + Mn | 2.0 | 0.50 | 1.45 | 0.374 |
| 7 | FeS + Mn | 4.0 | 0.50 | 2.73 | 0.195 |

These results show that manganese sulfide, even in the presence of an excess of manganese, will be converted to iron sulfide and enter the metal, the reaction, therefore, being reversible. Further, the greater the excess of manganese the lower the sulfur in the metal, regardless of whether the sulfur is originally present as Mns or as FeS. Comparing the tests made with the same concentrations of manganese and sulfur in the charge, but with the sulfur charged as MnS in the first case and FeS in the second, we have:

| | | Charge | | Ingot | |
|---|---|---|---|---|---|
| Run | Material Charged | Manganese, Per Cent | Sulfur, Per Cent | Manganese, Per Cent | Sulfur, Per Cent |
| 2 | MnS + Mn | 1.0 | 0.452 | 0.636 | 0.397 |
| 5 | FeS + Mn | 1.0 | 0.50 | 0.647 | 0.397 |
| 3 | Mns + Mn | 2.0 | 0.50 | 1.57 | 0.310 |
| 6 | FeS + Mn | 2.0 | 0.50 | 1.45 | 0.374 |
| 4 | MnS + Mn | 4.0 | 0.50 | 2.81 | 0.230 |
| 7 | FeS + Mn | 4.0 | 0.50 | 2.73 | 0.195 |

As the manganese excess increases the inclusions become darker, showing that the ratio of manganese sulfide to iron sulfide increases. This is to be expected as the equilibrium constant or ratio for the reaction is

$$K = \frac{(\text{Mns})\ \text{metal}}{(\text{FeS})\ \text{metal} \times (\text{Mn})\ \text{metal}}$$

from which it can be seen that as the concentration of manganese is raised the ratio $\frac{(\text{MnS})\ \text{metal}}{(\text{FeS})\ \text{metal}}$ must increase.

The authors wish to express appreciation to Mr. V. O. Homerberg, of the Massachusetts Institute of Technology, for the preparation of the photomicrographs. (Not shown).

(Note—The loss of manganese over that required to form Mns was the result primarily of oxidation of manganese, the electrolytic iron containing 0.44 per cent oxygen as surface oxidation picked up during pulverizing.)

## Practical Hint on Holding Locked Dies

### By Harold D. Kelly

One experienced in drop forging will appreciate a device whereby a perfectly matched forging can be produced from a pair of locked dies, without undue strain on the hammer and without the use of dowels.

Ordinarily the dies would be set as in A, Fig. 1, but the objection to this plan is that, when forging, the metal between the dies at b would throw the dies apart, the top die moving in the direction of arrow d, and the bottom die moving in the direction of e, thus producing a mismatched forging and causing undue strain on the hammer.

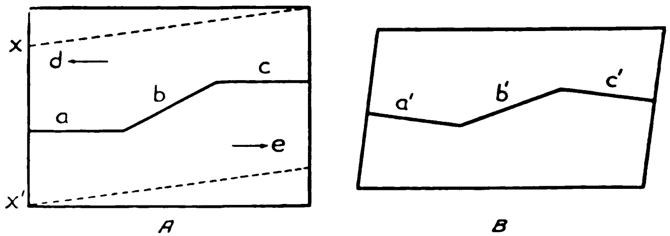

FIG. 1.

To overcome this, if the forging has a 7 deg. draught, tip the dies by planing off 5 deg. on the top and bottom dies along the lines x and x', causing the dies to set in the hammer as in B, Fig. 1. This overcomes the tendency for the dies to move apart as the slant on striking surfaces a and c offsets the slant on striking surface b.

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*Paper presented at the New York meeting of the American Institute of Mining and Metallurgical Engineers, February, 1925. (Copyright, 1925, by the American Institute of Mining and Metallurgical Engineers, Inc.)

†Research Associate, Massachusetts Institute of Technology, School of Chemical Engineering Practice.

‡Massachusetts Institute of Technology, Master's Thesis, 1923.

[1] Andrew McCance: "Non-Metallic Inclusions," Journal Iron and Steel Institute (1918) 97, 239.

[2] G. Rohl: "Constitution of Sulphide Enclosures in Iron and Steel. Carnegie Sch. Mem., Iron and Steel Inst. (1912) 4, 28.

# The POWER PLANT

## Pulverized Coke Braize Firing*

### Experience Has Shown That This Form of Fuel Preparation Is Practical Under Certain Conditions

By H. W. BROOKS†

At one of the steel plants at Birmingham, Ala., coke braize is being successfully burned in pulverized form. It is understood that under conditions of excess coke braize production this has also been done in one steel plant in Pennsylvania. Under certain price conditions during the war, coke braize has been economically burned in pulverized form in the cement industry. During a visit in Europe last year, I had the opportunity of seeing pulverized coke braize utilized at several plants in the Saar and Ruhr.

As there are many different varieties of coking coals, there are many different kinds of coke braize. Variations in coking conditions also serve to produce braizes of widely varying hardness and abrasiveness. Probably in a majority of cases it is not economical to burn coke braize in pulverized form. There are, however, cases where certain classes of coke braize are produced in certain quantities and at certain times where the burning of coke braize in pulverized form may be economically justified.

To the operator familiar only with the use of raw coal, two differences characterize the combustion of braize. One equally affects both stoker and pulverized firing, while the other is inherent to pulverized firing only. The former is caused by the absence of sufficient low ignition volatile matter to sustain initial inflammation between the ignition point of the carbon, of the coke, about 850 deg. F., and that of the moist carbon monoxide, about 1200 deg. F., which is substantially the only combustible gas formed during the process of combustion. In bituminous combustion, this 350 deg. gap is progressively bridged in seven stages by the successive ignition of distilled gases as follows:

| Gas | Ignition Range Deg. F. |
|---|---|
| Acetylene | 760- 820 |
| Propane | 900-1050 |
| Ethylene | 1000-1015 |
| Hydrogen | 1075-1095 |
| Ethane | 1100-1300 |
| Carbon monoxide (moist) | 1190-1220 |
| Methane | 1200-1380 |

In the combustion of pure carbon, anthracite or coke, radiant heat from specially designed arches and wall constructions must be made available to the flame, and the mixing and turbulent flow of gases must be accomplished, as has been described by Mr. Van Brunt for stoker firing. Otherwise flame propagation ceases between the first stage of ignition of carbon and the second stage of ignition of moist carbon monoxide, and the fire "goes out" either wholly or in part, resulting in excessive losses of unburned combustible in the refuse or ash. That this gap may also be bridged in pulverized fuel combustion is best evidenced by the fact that the method is actually in successful operation in numerous existing installations.

Figures are not immediately available on the Birmingham installation cited, but figures given below will give an idea of the relative ease of starting a furnace of this type by an operator of skill and experience. The Susquehanna Collieries, which burn anthracite in pulverized form, utilize for starting, kerosene in a small auxiliary burner similar to the design employed by the Bureau of Steam Engineering of the U. S. Navy. In 7 to 9 minutes, a cold boiler will sustain inflammation with the expenditure of but 5 to 7 gallons of kerosene, and in 30 to 35 minutes from starting from "cold" the boiler is ready to go on the line. A relatively hot furnace, off say 14 hours, will sustain inflammation within 4 to 5 minutes with the expenditure of but 2 to 3 gallons of kerosene, and such a boiler will be ready to go on the line within 10 minutes from starting.

The second difficulty, that of the abrasiveness of coke braize and resultant high pulverizer maintenance, is, of course, inherent only to firing in pulverized form. The Fuller-Lehigh Company has had considerable experience in pulverizing coke braize for use in foundry facing, paint filler and to some extent for burning. Naturally the plants were limited in size, the largest handling approximately 45 to 50 tons per day. The above installations, however, have given accurate data as to the capacity of the pulverizers. Mill capacities when grinding coke run from one-half to three-fifths of the capacities on bituminous coal. There is naturally considerable difference in the grindability of coke just as there is in coal. By taking the average records, the following figures can be used and considered conservative:

| | |
|---|---|
| Power—kwh. per ton of coke ground, pulverizers, 20 @ $0.01 per kwh. | $0.20 |
| Repair material pulverizers @ $0.10 per ton ground | .10 |
| Repair labor pulverizers @ $0.04 per ton ground | .04 |
| Operating labor on entire preparation plant @ $0.30 per ton | .30 |
| Power on drying, elevating, conveying, and auxiliary equipment, 3 kwh. per ton | .03 |
| Repairs on drying, elevating, conveying and auxiliary equipment | .02 |
| Operating material as grease, oil, waste, etc. | .02 |
| Total | **$0.71** |

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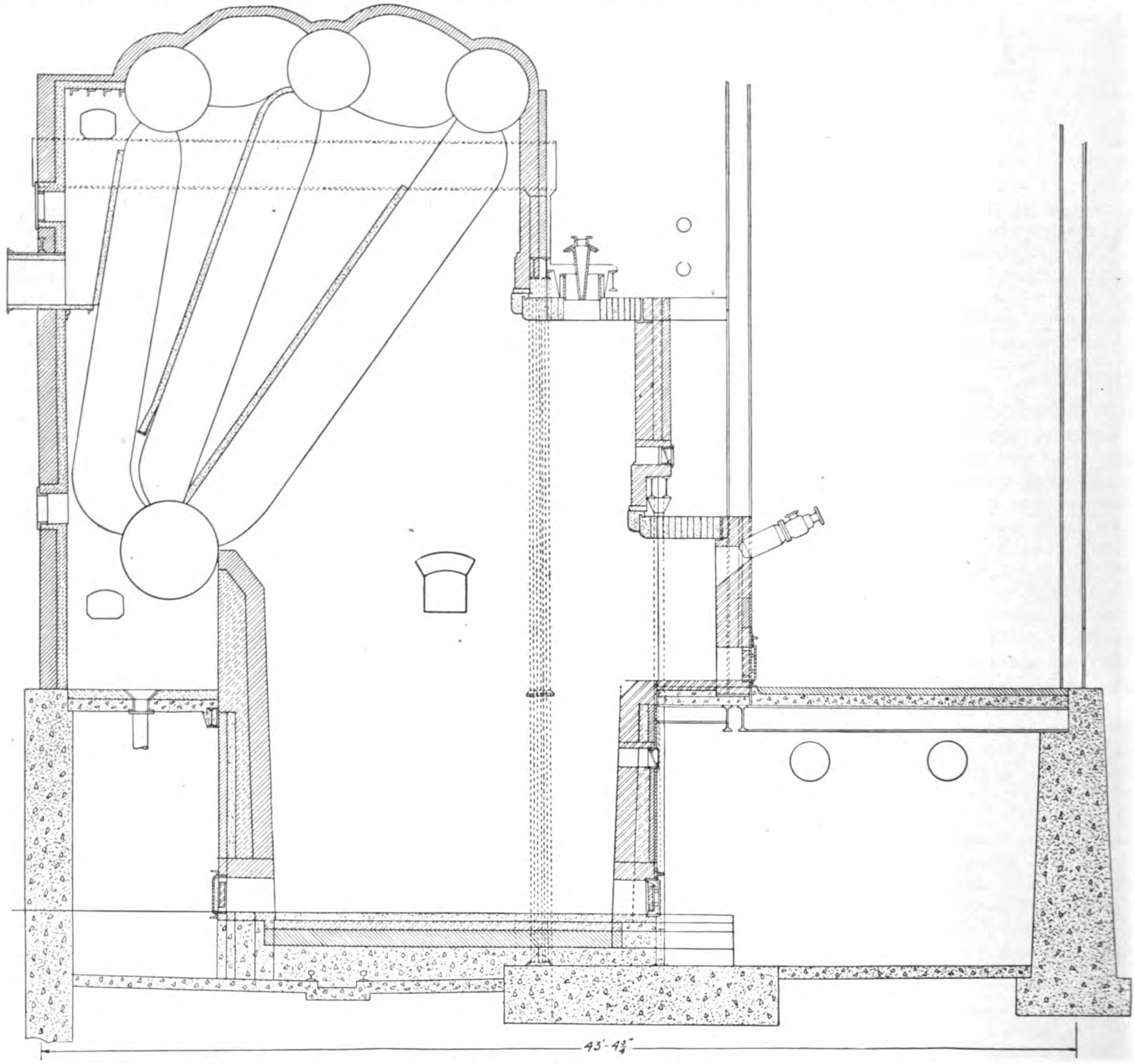
*Discussion of a paper by John Van Brunt entitled, "Generation of Steam from Coke Braize," presented at the Fuel Saving Conference of Iron and Steel Electrical Engineers at Pittsburgh, Pa., May 14, 1925.

†Consulting Engineer, Fuller-Lehigh Company, Fullerton, Pa.

To the above must be added the fixed charges and plant overhead which will vary, of course, according to the size o fthe plant. The above figures are based on a plant of 50 net tons per day, operating on a 16-hour basis.

The grinding of coke as well as anthracite coal has been considered by many engineers as costing nearly double as much as bituminous coal, due to the fact that wear and tear on the pulverizers is double that incident to grinding bituminous. On the other hand, the operating labor charges in the plant are little if any more per ton. The same number of men will operate a braize plant as are required in a bituminous plant. Initial and operating costs of elevating, conveying, and storage amount to the same either for braize or coal. The pulverizing unit alone is the only part of the system which must be increased in size for braize utilization. Correspondingly this necessitates increased power for pulverizing, the increase being of the order of 60 per cent over that required for bituminous pulverization. Decreased drying cost caused by the uniform sizing of the braize and decreased crushing cost owing to no preliminary crushing being required both tend to compensate for the higher maintenance cost of the pulverizer. Thus, even though interest and labor charges on the pulverizers may be double those of a bituminous plant, the total increased cost of operation of the system as a whole may be only 15 to 20 per cent higher.



*A cross-section of boiler furnace designed to successfully burn coke-braize in combination with a gas fuel. This layout offers a wide latitude in full combinations.*

We have hundreds of mills in operation throughout the world grinding cement clinker, which is not only harder and more abrasive than coke, but a great deal larger in size, and on which the specifications for fineness are most rigid. From these many installations we have a very complete record as to operating costs, and these figures are well in line with those given above.

**(Concluded on page 502)**

# 1925 Annual Meeting of A. S. M. E.

## Sessions Will Be Held During Power Show Week

NOVEMBER 30 through December 4 are the days when the forty-sixth annual meeting of the American Society of Mechanical Engineers will be held in New York City. Judging from the list of outstanding speakers and from the advance plans for technical sessions, the meeting will attract an attendance that will exceed the 1924 event, which was the largest the Society ever held with 2,174 registered.

The Professional Divisions have been at work on their programs in co-operation with the Committee on Meetings and Program since April and efforts are being exerted to complete the program for publication in the October 22 issue of the A.S.M.E. News.

About 45 papers will be presented at the Meeting and following the procedure inaugurated last year, a special issue of "Mechanical Engineering" will be put in the mails on November 15 containing a portion of the papers and synopses of the balance. This procedure has been developed to give the members of the Society an opportunity to study the papers in advance of the meeting so that the discussion which is the life of the meeting may be well-considered and pertinent.

One of the feature events of the Meeting will be the presentation of Honorary Membership in the Society to the Honorable Herbert Hoover and to Past-President Worcester R. Warner. This event will occur on Tuesday evening, December 1, just preceding the Presidential address by Dr. William F. Durand. Following the address there will be the usual reception.

An innovation at the coming Meeting will be the delivery of the first Henry R. Towne and Robert Henry Thurston Lectures. The Towne Lecture will be given on Tuesday afternoon, December 1, at 4:30 P. M., and will deal with the relation of Engineering and Economics. The Thurston Lecture on Engineering and Science will be given on Thursday afternoon, December 3, at 4:30 P. M. The lecturers are to be elected by Council at the Altoona Meeting of the Society.

The entertainment program which was so successful alst year will be repeated. The annual dinner will be held Wednesday evening, December 2, and will furnish the opportunity for greeting those who joined the Society during the previous year as well as a chance for the renewal of friendships. The speaker will be one of the leading statesmen of the country. The program will be short and dancing will follow. The Informal Get-Together on Monday evening will provide the curtain-raiser to the Meeting proper.

The ladies are making extensive preparations for an interesting five days. Their program will include an Open-house Monday evening, a luncheon and the ever-popular Ladies' Tea and Reception on Wednesday afternoon. The usual list of excursions will give an opportunity for out-of-town ladies to see the sights of the city.

### Progress Session.

The Business Meeting on Wednesday afternoon will be featured by the usual Council report and by an especially valuable report on the Study of Mechanical Engineering Education. It will be followed by a General Session at which each of the Professional Divisions will present reports of progress in their particular fields during the past year. These reports should be of tremendous value in establishing the research and standardization programs of the Society.

### National Defense Session.

The auditorium of the Building will be used for the National Defense Session on Thursday evening when industrial leaders will report the progress that is being made in perfecting the national program of industrial preparedness.

### Machine Shop and Machine Design.

The renewal of activity in this important field of mechainical engineering is demonstrated by the fact that there will be five sessions at the Meeting. The topics to be discussed include—belt transmission, optical measurement, gears, machine tool design, spring design, lubrication, torsional stress in shafts, vibration in steam turbine buckets, and vibrations in shafts.

### Management.

Two sessions are listed for management discussions on industrial psychology, plant design, production control of newsprint manufacture, and fatigue. The Taylor Society is co-operating in this program.

### Session with A. S. R. E.

The A. S. R. E. is co-operating in one session which will take up centrifugal compressors in two papers, one dealing with the centrifugal compressors in two papers, one dealing with the centrifugal compressor as a refrigerating machine and the other discussing the heat balance of the centrifugal compressor.

### Industrial Session.

The problem of materials handling will be discussed from the point of view of safety in one session. The wood industries promises a strong program of papers in its field. The textile discussions will include weaving machinery and motor applications to textile machinery. The Aeronautics Session will deal with the commercial possibilities of the airship and recent technical advances in aeronautics.

An important session will deal with training for industries and receive reports on apprenticeship abroad and apprenticeship in the building trades.

### Fuel and Power Sessions.

This phase of the program will be approached from many more angles than usual. Industrial furnaces will be dealt with exhaustively in one session. The Oil and Gas Power Session will take up transmission marine auxiliaries and large gas engines. Industrial power will come in for thorough discussion centered about papers on higher steam pressures and industrial power costs. Power plant materials will furnish the topic for a strong session at which steel castings, bolt materials, boiler tube corrosion, and refractories will be discussed. A general power session will deal with radiant heat absorption, the effect of steam bleeding and recent developments at the Colfax Station.

The usual progress reports on the steam investigation and a public hearing on the Power Test Codes will also be held.

## Italian Demand for Iron and Steel Increasing

After reaching its low point in 1921, the Italian iron and steel industry has been gradually increasing its output, and in 1924 the production amounted to 266,960, metric tons of pig iron and 1,179,200 tons of steel, according to the Iron and Steel Division of the Department of Commerce. The monthly rate of production in the first half of 1925 was 17 per cent greater than that in 1924.

Although there was a great need in Italy for iron and steel for replacements and for construction immediately after the World War, a general depression resulted in the closing down of the important iron and steed works at Bagnoli in 1919, the shutting down of blast furnaces at Porto Ferraio and Piombo, and a general reduction of activity among other plants.

During the war, the iron and steel making capacity of Italy had been greatly extended, modern large works being erected to fill the enhanced emergency requirements. These expensive mills and furnaces could not be kept running at a profit when the depression restricted the purchasing power of the consuming industries. Handicapped by a lack of industrial coal and by the limited supply of accessible iron ore, the Italian iron and steel producers were unable to compete successfully with the other Continental manufacturers even in their home market.

The increased output demonstrated the expanded consumption at home, and with improved economic conditions, Italy began to satisfy her urgent need for iron and steel. The building trades, the electrical and hydro-electrical companies, and firms constructing aqueducts came into the market for materials. Conditions steadily improved, and with the expansion of activity in the domestic plants came an increase in the influx of foreign-made iron and steel.

Imports of pig iron and ferro-alloys and of scrap were greatly augmented for these materials are essential to the operations of the Italian rolling mills. During the first six months of 1925 the importation of scrap iron and steel approached 590,000 metric tons, more than double the receipts for the corresponding periods of the two preceding years. Pig iron and ferro-alloys shipments nearly doubled, and purchases of foreign semi-finished steel rose from several thousand tons to 90,000 tons. The increase in the trade in bars, rods, and shapes was great. On the other hand, it is interesting to note that foreign-made rails and accessories lost ground in the Italian market, in favor of the domestically rolled product.

The United States so far has had little share in the Italian transactions in iron and steel, shipping to that country only 22,511 gross tons during the entire year 1924. Three fourths of this tonnage was scrap, the bulk of the remainder being tin plate. Some small consignments of welded black pipe, steel sheets, and steel castings were also made. For the first half of 1925 American exporters sent to Italy more iron and steel than in the whole of 1924. Of the 26,177 gross tons shipped in the 1925 period, however, 19,091 tons were scrap which left American ports in the months of May and June. Tin plate was again the only other item of importance supplied to Italian consumers.

Italy's need for scrap is urgent. Since the War a very considerable percentage of scrap has been used in the Italian steel furnaces. For a time the surplus war material which was sold at low prices by the Government was sufficient to supply a large part of the demand. As this source became gradually exhausted, Italy began to draw heavily upon the scrap stocks of other countries, particularly France. Recently France has restricted the exportation of steel scrap to Italy, dependent upon the quantity of French manufactured steel products which Italy should import.

Where and how to obtain their supplies of scrap at the most advantagous terms is now, therefore, a vital problem for the Italian steel producers. Until such time as sufficient iron ore or pig iron and scrap and coking coal can be obtained at a figure low enough to enable the Italian steel mills to meet German, French, and British competition in the open domestic market, the practicability of the large steel plants and costly equipment will be a subject of controversy.

## Mechanical Stokers

The Department of Commerce announces the following statistics on Mechanical Stokers for the month of October, 1925, compiled from reports received from 13 establishments. Comparative statistics are presented by months from October, 1923 to October, 1925.

| YEAR AND MONTH | Establishments reporting (Number) | STOKERS SOLD | | INSTALLED UNDER | | | |
|---|---|---|---|---|---|---|---|
| | | | | Fire-tube boilers | | Water-tube boilers | |
| | | Number | Hp. | Number | Hp. | Number | Hp. |
| 1925 | | | | | | | |
| October .. | 13 | 114 | 53,451 | 22 | 3,864 | 92 | 49,587 |
| September . | 13 | 119 | 38,155 | 34 | 7,563 | 85 | 30,592 |
| August ... | 13 | 91 | 29,865 | 27 | 3,880 | 64 | 25,985 |
| July ...... | 13 | 147 | 58,719 | 30 | 5,075 | 117 | 53,644 |
| June ...... | 13 | 128 | 44,095 | 26 | 4,625 | 102 | 39,470 |
| May ...... | 13 | 122 | 55,588 | 23 | 3,934 | 99 | 51,654 |
| April ..... | 13 | 120 | 47,627 | 23 | 5,893 | 97 | 41,734 |
| March .... | 13 | 131 | 71,099 | 17 | 2,446 | 114 | 58,653 |
| February .. | 13 | 135 | 46,298 | 28 | 4,905 | 107 | 41,393 |
| January ... | 13 | 57 | 27,871 | 4 | 870 | 53 | 27,001 |
| 1924 | | | | | | | |
| December . | 13 | 91 | 31,732 | 18 | 1,788 | 73 | 29,944 |
| November . | 13 | 106 | 37,167 | 11 | 1,675 | 95 | 35,492 |
| October ... | 13 | 104 | 58,565 | 7 | 1,702 | 97 | 56,863 |
| September . | 13 | 73 | 25,988 | 27 | 6,646 | 46 | 19,342 |
| August ... | *13 | 94 | 41,931 | 17 | 2,486 | 77 | 39,445 |
| July ...... | 15 | 115 | 37,759 | 14 | 1,660 | 101 | 36,099 |
| June ...... | 15 | 102 | 35,549 | 19 | 2,724 | 83 | 32,825 |
| May ...... | 15 | 64 | 34,447 | 3 | 550 | 61 | 33,897 |
| April ..... | 15 | 89 | 47,939 | 15 | 1,970 | 74 | 45,969 |
| March .... | 15 | 89 | 34,597 | 12 | 1,625 | 77 | 32,972 |
| February .. | 15 | 110 | 62,113 | 11 | 1,525 | 99 | 60,588 |
| January ... | 15 | 91 | 66,492 | 7 | 1,044 | 84 | 65,448 |
| 1923 | | | | | | | |
| December . | 15 | 73 | 32,517 | 17 | 2,820 | 56 | 29,697 |
| November . | 15 | 50 | 16,241 | 10 | 1,300 | 40 | 14,941 |
| October .. | 15 | 88 | 32,576 | 14 | 2,330 | 74 | 30,246 |

*Two establishments consolidated with other companies.

## Prepares Lecture on Heat Insulation

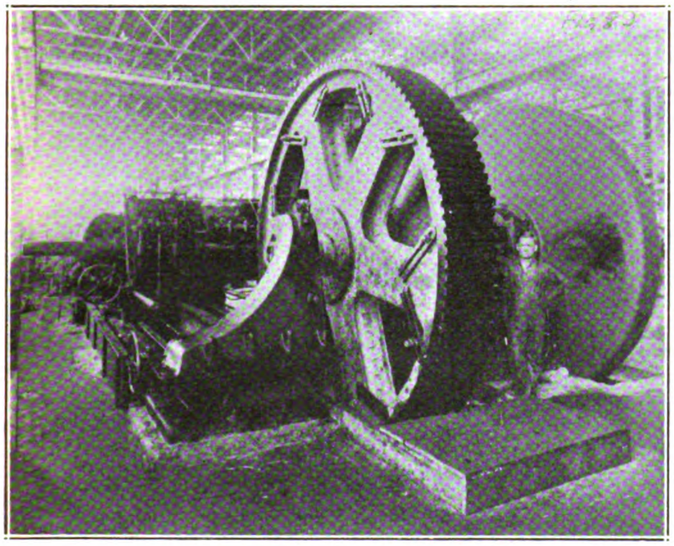
The Celite Products Company, Los Angeles, recently prepared a bulletin entitled "High Temperature Insulation," which is a compilation of data on the heat transmission methods. It takes into consideration the fact that the waste of industrial heat annually in this country is approximately a billion dollars, heat losses due to conduction and radiation averaging over 25 per cent of the total available heat in the fuel. The material was prepared and arranged primarily to be used with lantern slides as a lecture to be used by the engineering departments of the leading universities in the country. To give it a wider circulation, however, it has been printed.

## WITH THE EQUIPMENT MANUFACTURERS

# The Sykes Herringbone Gear Generator

### PART II.

THE large hand wheel shown in the foreground of illustrations Figs. 3 and 4, (see November), moves the work carrying saddle towards or away form the cutters. It also serves to determine the depth the teeth are to be cut. This hand wheel will be controlled automatically in the machines at present under construction, the illusttrations do not show this particular controlling mechanism. It is designed to feed the work towards the cutters and to stop when the depth is obtained. With this mechanism the machines are entirely automatic. It is only intended, however, to fit this automatic depth feed mechanism to the smaller sizes of machines as it is not considered necessary for the larger machines, which are seldom engaged on repetition work.

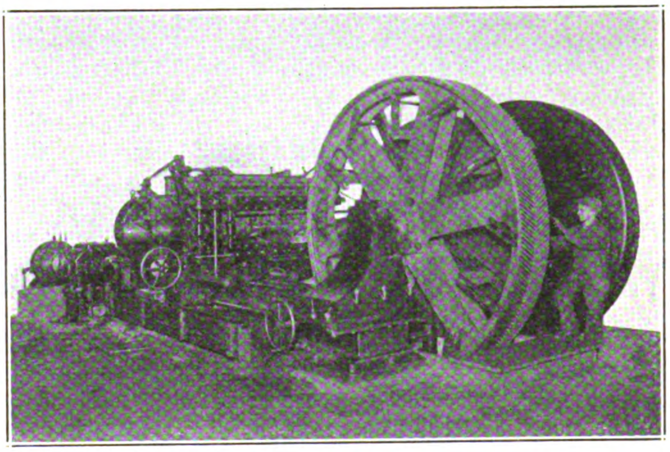


The large size machine is shown in Figs. 8 and 9. In principle it is the same as the small size machine already described, in detail design it is quite different. The reason for this is that the wheels dealt with on the large size machines are much heavier than that part of the machine carrying the cutter operating mechanism. It has therefore been found advantageous to mount the head stock carrying the wheel blanks rigidly, and to mount the cutter operating mechanism on a saddle. It has further been found desirable to provide eight speed changes and in addition a direct motor drive through a magnetic clutch.

Due to the large size of the machine, and the desirability of the greatest facility in operating and setting up, all control movements are made electrically. The saddle is moved to and fro by an independent electric motor; starting and stopping the machine is effected through the magnetic clutch already referred to; the feed changes, and the disengagement and engagement of the feed mechanism, is operated magnetically by means of solenoids. The pump for the cooler is also driven by a separate motor, and there is a fourth motor for turning around the main work spindle so as to test the arbors for truth, and also the wheel blanks after they are mounted. All these electric controls are operated by push buttons on a switch board placed in front of the machine.

Fig. 8 left shows the No. 12 machine cutting a large Herringbone gear, Fig. 9 below shows the same size machine cutting a 4 in. pitch spur gear. It is believed that these large machines installed at Buffalo have a larger capacit ythan any other herringbone gear cutting machines at present existing in any part of the world. The large wheel shown mounted on the machine in Fig. 9 is for a sugar mill drive.

The cutters used in the Sykes Generating machines are made with the greatest precision, after they are hardened they are sharpened on the ends of the teeth only. The tooth contours are generated involute to a base cylinder, irrespective of the outside diameter which varies slightly depending upon whether the cutter is new or badly worn. The tooth contour is involute to one base circle, and it will therefore always cut the same involute tooth shape whether it is new or almost worn out. All the cutters are made with the base circle near the root of the teeth so that the whole cutting portion of the tooth contour is involute. The side relief on the teeth of the cutters is made in definite relation to the top relief, thus ensuring that the thickness of the cutter teeth varies from front to back in correct proportion to the variation in diameter thus ensuring that the cutters will always cut exactly the same thickness of tooth in proportion to the depth of tooth. It is therefore claimed that the Sykes cutters will consistently generate exactly the same teeth both as regards thickness and tooth contour as well as exactly the same helix, whether they are worn or new.



It is fairly widely known that the type of cutter will generate gears having any number of teeth, from one tooth up to a rack, which represents an infinite number of teeth, therefore in the Sykes machines only one pair of cutters of any particular pitch is necessary to cut spur gears as well as Helical or Herringbone gears. To change the machine so that it will cut either kind of teeth the only alteration necessary is the substitution of straight guides for helical guides, and straight tooth cutters for helical cutters, or vice versa. These changes are made very easily and take but a few minutes on the smaller machines.

The smaller size cutters are made from solid high speed steel forgings of the best quailty. The larger cutters however are made with oil toughened bodies and with high speed steel teeth which are secured by ingenious means to the bodies and can be changed when worn out or if accidentally broken. This construction results in very economical, very durable and exceedingly efficient cutters.

From the illustrations Fig. 1 it will be seen that the sharpening of the faces of the cutting teeth is somewhat special. It is desirable, however, to explain that this sharpening is easily done on a standard tool room universal cutter sharpening machine.

There are many interesting mechanical details in connection with the Sykes machine which are worthy of careful study by machine designers, but a full explanation of these details would be tedious and uninteresting for the majority of readers.

The machines as already explained are made in four sizes, each of which has the following capacity:— No. 1½ cuts from ¼ in. up to 19 in. dia 8 in. face 3 in. pitch. No. 2 from ½ in. dia. up to 30 in. dia. 12 in. face 2 D. P. No. 4 from 1 in. up to 53 in. 18 in face 2 D. P. No. 6 from 2 in. dia. up to 72 in. dia. 20 in. face 1½ D. P. No. 12 from 3 in. dia. up to 18 ft. dia. 54 in. face 1 D. P. 4 in. pitch straight teeth.

The helical guides are often referred to as cams, actually they are screws, in action they are pulled through or pushed through fixed nuts which are a counterpart of the screws of much shorter length. The screws have a long lead and they impart to the cutters exactly the same lead. In the small machine illustrated the lead of the guides is 21.765 inches, therefore if the cutter could make a stroke equal to this lead it would turn during one stroke exactly one revolution. It is a fundamental principle that if two helical gears are to gear together with their axis parallel, that the lead of the helices be in direct proportion to the number of teeth. For instance if a pinion having 20 teeth and a lead of 30 in. has to gear with a wheel having 40 teeth, the lead of this wheel must be 60 in. It will be understood after a little consideration that the diameter of the cutter has no influence on the helix angle of the gears cut. Irrespective of any question of diameter every wheel cut on a Sykes Helical machine will have a lead in direct proportion to the lead of the helical trace of the cutters, and to the number of teeth in the cutters, and the number of teeth cut. The diameter of the cutters does not influence the lead cut by the cutters.

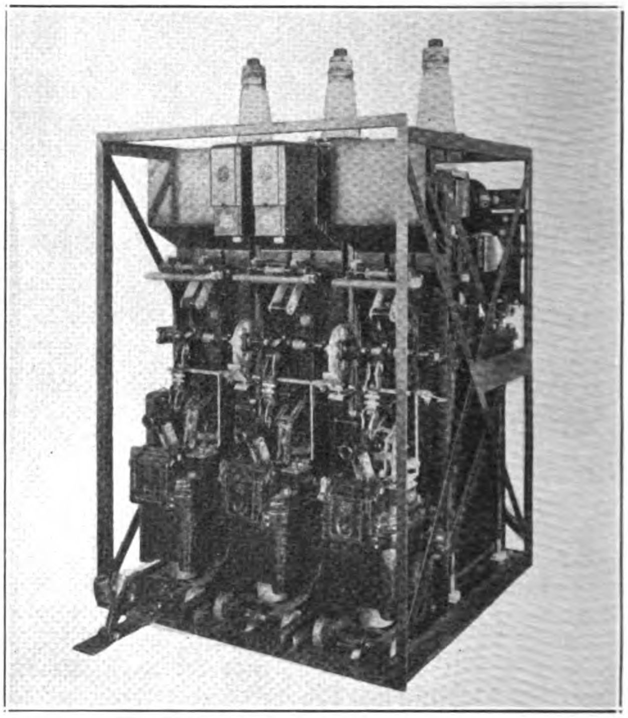
In connection with the fundamental principles of the Sykes machines it may be of interest to those having a desire of sound understanding that there are three basic elements upon which all other considerations can be built; they are as follows: The number of teeth in each cutter, the base circle of the involute tooth curves, and the lead of the helical guides. The first two are fixed when the cutters are made, and the third when the guides are made.

It is not difficult to deduce from the above that it is possible with one pair of cutters to cut a variety of different pitches because the pitch of involute gears depends on the distance between the axis of any gear pair. The Sykes cutters themselves determine the base circle diameter which will be cut on any gear, but the base circle diameter does not determine the pitch circle diameter. Non-standard pitches may be cut by cutters which are nominally of standard pitch. It can be demonstrated mathematically that with a limited range of cutters any pitch may be generated on Sykes machines, that is to say any standard or non-standard pitch within the maximum and minimum of the range of cutters referred to.

## New Housing Framework

A new, "ready-to-use" housing framework for Type FK-54 oil circuit breakers is now being manufactured by the General Electric Company, designed primarily to meet the demand for equipment which can be installed with a minimum of skilled work.

The three runways of the framework are welded in one solid piece, forming a base plate to which is welded an overhead structure of angles and steel straps. While the design is simplified, there is sufficient strength to hold bushings, contacts and runways in permanent alignment. To install, it is merely necessary to run the housing into the cell, secure it with grouting through the base plate and make the usual connections.



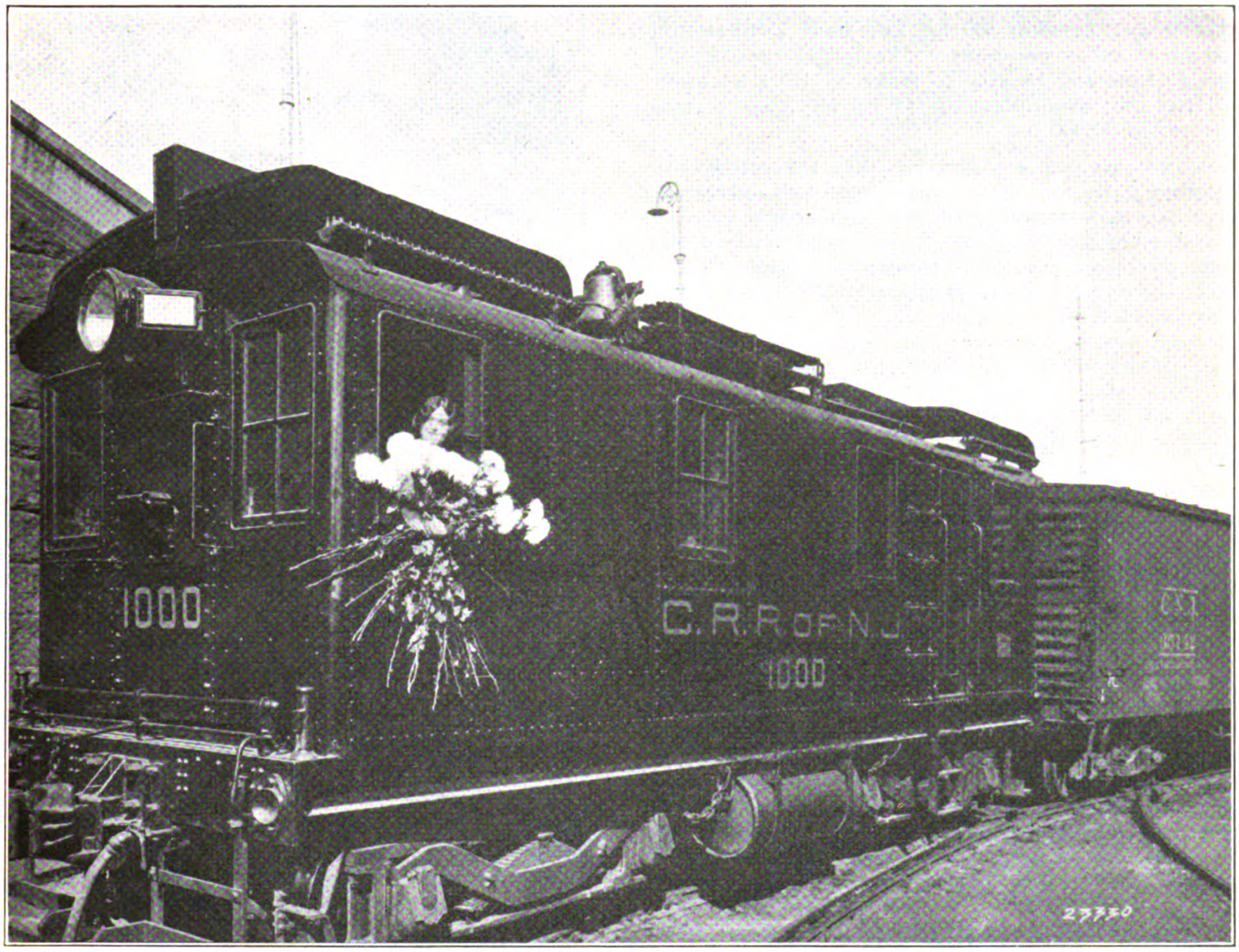
Units are securely interlocked against any attempted withdrawal of closed breakers, and there is a positive interlock between tripping coils so that the opening of one unit opens the entire circuit. A ground-

(Concluded on page 500)

## Oil-Electric Locomotive

THE recent purchase of a 60-ton oil-electric locomotive by the Central Railroad of New Jersey followed closely by the acquisition of a 100-ton type by the Long Island Railroad marks a new era in railroad engineering. If the service performances of these locomotives bear out the demonstrating performances, the wide substitution of the oil-electric locomotive for the steam engine in railroading in the United States is foreseen.

The oil-electric locomotive, with its internal combustion engine and electric generator, is the product of three of the leading manufacturers in the engineering field—the American Locomotive, the General Electric and the Ingersoll-Rand Companies.



The oil engine, which is the product of the Ingersoll-Rand Company, has six cylinders and is of the 4 cycle, single acting, vertical type. Fuel oil is injected directly into each cylinder through two opposite spray nozzles situated in the combustion chamber. This fuel is delivered, under pressure, by a pump directly connected with the main shafting. The heat resulting from sufficient compression ignites the oil and the power stroke is thus started—in other words the action is similar to that of an ordinary automobile engine with the heat of compression doing the work of the spark plug. The pump which injects the oil serves all six cylinders and is automatically controlled to feed each chamber as oil is needed. For efficient action the engine requires that the oil have a flash point of not less than 150 deg. F. A forced feed system of lubrication is used and functions through a gear driven pump in the crank case. Circulating water is distributed to all parts of the engine by a centrifugal pump attached to the crank shaft.

To start the engine compressed air at a pressure of 200 pounds is admitted successively to each cylinder, through mechanically operated starting valves. In order that there be a continuous supply of starting air, two small compressors are provided, one driven by an auxiliary engine and the other by the main oil engine. The latter compressor keeps the flasks of starting air continually charged.

Directly connected with the oil engine is a General Electric generator, with a voltage ranging from 200 to 750. The output is regulated by throttle to the demands made upon the dynamo by the tractive motors.

The control of the locomotive is extremely simple. The engineer has only to manipulate two control handles. One that serves as a throttle lever to control the output of the engine; while the other is a master controller or electric switch which puts the tractive motors either in series or in parallel as circumstances may require.

Therefore with the throttle lever set at any desired speed, the generator delivers to the four driving motors the amount of energy necessary to turn the driving wheel at the prescribed speed. The tractive efforts can thus be varied to suit any operating condition.

Up-to-date these oil-electric locomotives have been constructed for both slow speed switching and for road service. Two slow-speed types have been built weighing respectively 60 and 100 tons, and capable of developing 300 hp. and 600 hp. The smaller is capable of traveling at 30 miles an hour and exerts a tractive effort of 36,000 lbs. The larger unit can make the same maximum speed and develop a tractive effort of 60,000 lbs.

Designs have been developed for two road types. The 60-ton road locomotive will have a tractive effort of 23,000 lbs., develop 300 hp. and have a maximum speed of 45 miles per hour. The larger type would weigh 85 tons and be able to make 55 miles an hour. The latter unit would develop 600 hp. and exert a tractive effort of 50,000 lbs.

Performance reports disclose that the oil-electric locomotive is far more economical in cost of operating, than a steam locomotive of the same capacity. In the first place the thermal efficiency referred to the driving wheels of an internal combustion engine driven electric locomotive is approximately 25-27 per cent. Steam locomotives can show only 5-8 per cent. The interposed system of electric drive used in the new oil-electric locomotive protects the engine from the strains and shocks that a steam engine would have to contend with because of direct drive. Also this absence of direct drive permits the engine to run at its most efficient, and, therfore, at its most economical speed—and the dynamo tractors, providing the equivalent of countless gear changes. And last, but not the least of the merits of the oil-electric locomotive is the way the generator and driving motors automatically adjust themselves in response to the demand made upon them.

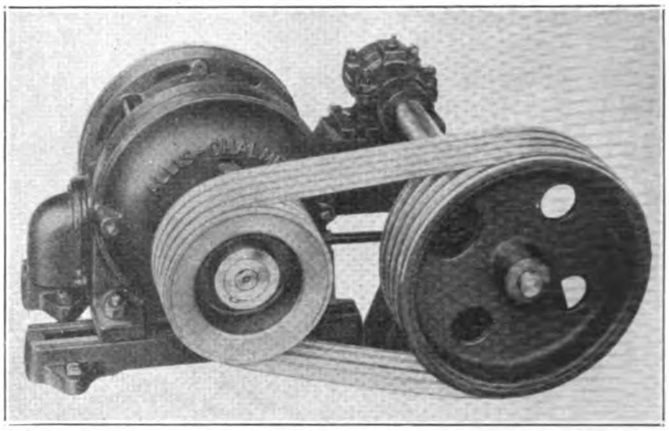
The last few years have witnessed the gradual disappearance of steam in many industries. Electricity has frequently taken its place. But apart from what the oil-electric locomotive represents as a notable advance in railway engineering, the development of this type of tractor promises to prove a source of great relief to thousands of people, now living close to railroad terminals, where they are exposed to smoke and to the noisy din of active or waiting locomotives.

## The Texrope Drive

An important development in the field of power transmission machinery has just been announced by the Allis-Chalmers Mfg. Company, who have recently perfected an entirely new type of short center, flexible drive, known as the Texrope Drive.

The Texrope Drive consists of two grooved sheaves and a number of specially constructed endless "V" belts. The sheaves are set just far enough apart so that the belts fit the grooves without either tension or slack.

Previously no short center drive existed which did not have slip, back lash or lost motion, which caused jerky starting and uneven running. Since the Texrope belts just fit the sheaves, there is no slack or lost motion in the drive. Because of the "V" construction, they cannot slip, as the harder the pull the more firmly the belts grip the grooves. Being elastic and stretchable, they cannot jerk, either in starting, acceleration or running, nor can they transmit vibrations, but act as cushions between the driving and driven machines. Therefore smoothness of transmission never attained before is delivered by the Texrope Drive, as opposed to the series of linear pulsations delivered by the ordinary short center drive.



Bearing pressures are low, since no belt tension is employed. The drive occupies very little space. It is silent, perfecty clean, unaffected by moisture or dirt, and is safe, simple and trouble proof. Since there is no slip, the speed ratios are fixed and exact. It is durable, and each belt carries its proportional share of the load.

Texrope Drives from ½ to 250 hp., with ratios up to 7 to 1 and belt speed from 800-6,000 feet have already been placed in service. They have been applied to nearly every industry, notably textile machinery, fans and blowers, machine tools, food manufacturing machines, refrigeration, mining, crushing, wood and metal working machinery, elevators and conveyors, paper, flour and rubber mill drives, etc.

## New Housing Framework

(Continued from page 498)

ing device on each breaker, consisting of a long blade on the housing which engages a spring clip on the unit, gives grounding protection until the main contacts have been separated three inches.

All single-pole units can be assembled one, two, three or four poles. At 7,500 volts, the ampere capacities are 400, 600, 800, 1,200, 1,600 and 2,000 amperes. The interrupting capacity is 10,500 amperes at 7,500 volts for two, three or four-pole operation.

Another advantage of this new housing framework is the simplification in locating the three top bushings all time-consuming adjusting being eliminated. The bushings are so arranged that contacts are in perfect alignment before the housing leaves the factory. Although these bushings are removed for shipping and cannot be replaced until the housing is in its cell, a system of numbers and dowels enables the user to replace the bushings in the same alignment obtained at the factory. Mounting plates are not interchangeable. Rear bushings are shipped in proper location.

# TRADE NOTES AND PUBLICATIONS

At a recent meeting of the Board of Directors of the Prest-O-Lite Company, Inc., Mr. M. J. Carney, formerly president, was elected chairman of the board. Mr. William F. Barrett, formerly vice president, was elected to the presidency. Mr. Ralph R. Browning was elected vice president in charge of acetylene sales activities. Mr. R. J. Hoffman was re-elected vice president in charge of storage battery and automotive divisions.

There was recently incorporated in the State of New York a company known as the Bar & Billet Scraper Company, Inc., which has taken over the patents and patent rights for the United States and foreign countries for a mechanical device for hot scraping of billets and sheet bars, during the process of rolling. The Bar & Billet Scraper Company, Inc., is located in the offices of Perin & Marshall, Consulting Engineers, 40 West Fortieth Street, New York City. The officers are: Frank L. Estep, president; Harry Dobrin, vice president; D. J. Ogilvie, secretary and treasurer.

Announcement has been made by officials of the Westinghouse Electric & Manufacturing Company of the appointment of James R. Thompson as works manager of the Trafford foundry of the company. Mr. Thompson has been with the Westinghouse organization nearly 30 years and has served for the past four years as assistant works manager under Mr. August Slusser, works manager, who died recently.

Mr. Thompson is well known in the Pittsburgh district, in which he was born and where he has resided all his life. He entered the Westinghouse organization in 1897 as a time clerk in the Westinghouse Machine Company, remaining with that organization in a number of capacities until he assumed charge of the offices of the Trafford works in 1904. A few years later he was made assistant superintendent under Mr. Slusser, and four years ago assistant works manager when Mr. Slusser was made manager. Mr. Thompson is a member of the Pittsburgh Foundrymen's Association.

New bulletins, Nos. 118 and 118-A, describing the Apex $CO_2$ recorder and indicator, are now ready for distribution by the Uehling Instrument Company of Paterson, N. J. These instruments operate on the orifice principle and do not employ chemical solutions. The principle of operation is fully explained in the bulletins.

Mr. P. J. Riccobene has recently joined the home office sales organization of the Uehling Instrument Company, 473 Getty Avenue, Paterson, N. J. Mr. Riccobene is a graduate of New York University in the department of Mechanical Engineering and is a junior member of the A. S. M. E.

The Uehling Instrument Company of Paterson, N. J., recently appointed the Ernest E. Lee Company, 115 South Dearborn Street, Chicago, to represent them in Northern Illinois and Northern Indiana in connection with the sale of $CO_2$ recorders, fuel waste meters and other power plant instruments.

The Coon De Visser Company, who have been representing the Uehling Instrument Company for several years in Michigan, have just moved from 1772 West Lafayette Boulevard to 2051 West Lafayette Boulevard, Detroit, Mich.

The Uehling Instrument Company of Paterson, N. J., report an exceptional demand for their Apex $CO_2$ recorders in the sugar producing fields, important orders for these instruments having been received recently from the Cuban Dominican Sugar Company, Sula Sugar Company of Honduras, Gray's Inn Central Sugar Factory of Jamaica, Dominion Sugar Company of Ontario, Colonial Sugars Company of Louisiana and Central Romana of Dominican Republic.

Pennsylvania Pump & Compressor Company, Easton, Pa., now have ready for distribution a new General Products Catalog, No. 125. This catalog is designed for the busy executive who wishes to have placed before him, in clear-cut, concise form, a comprehensive view of the company's complete line of products. The catalog is well illustrated.

Effective November 1, 1025, Mr. John H. Bode, vice president of Mackintosh-Hemphill Company, resigned to accept the presidency of the Wellman-Seaver-Morgan Company. Mr. C. V. Wilt has been placed in charge of operations in the capacity of assistant to president, and Mr. A. H. Baum as second assistant to president.

The Northern Engineering Works, of Detroit, Mich., builders of Northern "Standart-ized" cranes and hoists, have recently announced a new member of their electric hoist family, known as the Northern "Standart-ized Hi-Lift."

This new hoist embodies all the essential features included in the Standart-ized five-ton crane design, which has proven so successful and been one of the company's biggest sellers. The design of the hoist meets all the up-to-date features and requirements, including simplicity, accessibility, extremely high lift, a feature regarded as most essential in the present-day application of electric hoists, completely enclosed gears running in lubrication, gears made of hammered steel and case hardened, the drum of which is of large diameter and is of the grooved type. The hoist is provided with two brakes for holding and controlling the load, a top and bottom limit stop, roller bearings throughout. One especially outstanding feature of the construction provides that any standard make of motor can be applied.

In bringing out this new hoist the Northern Engineering Works feel that they have covered requirements which have long been demanded of hoist builders, but which have never heretofore been embodied in one design.

## A Protest by Industry

A rebellion by industry against the constant and growing intrusion of the government into the field of business activity is taking form. After watching bureaucracy extend itself amazingly during the post-war years in federal, state, county and city governments to the detriment of private initiative, leaders engaged in all types of business pursuits are now planning to offer stubborn resistance.

The first marker of the new movement is found in the arrangement of details for a mass meeting of industrial leaders to be held at Washington, December 10. The official call for this meeting is now in the hands of executives of 300 trade associations and other industrial organizations.

The official call carries the names of the following members of the planning committee: Homer L. Ferguson, Newport News, Va., former president of the Chamber of Commerce of the United States and president of Newport News Shipbuilding Company; F. Highland Burns, Baltimore, president, Maryland Casualty Company, and president, International Association of Casualty and Surety Underwriters; J. E. Edgerton, Nashville, president of the National Association of Manufacturers, and president, Lebanon Woolen Mills, and General R. C. Marshall, Jr., general manager, Association General Contractors of America, who is chairman of the committee.

A preliminary meeting has already been held in Washington, with representatives of 22 leading trade associations present. The result of this meeting was appointment of the planning committee to issue the call for the December meeting and to suggest a program of action for the campaign.

The meeting, leaders of the movement now in Washington declare, will not be directed against governmental regulation of industry, but its full force will be thrown into opposition of the practice under which tax-paying business firms are forced to finance the government as an active competitor.

Preliminary study of the situation has definitely linked penetration of the government into business with desires by those in public office to perpetuate their tenure, magnify their functions or enlarge the field for political control and "spoils." These desires have been advanced in a manner so subtle as to cause Congress and the appropriating bodies of smaller units of government unwittingly to uphold the general practice.

The December meeting will be held in Washington two days after Congress convenes. Those who are anticipating the meeting's possibilities see a chance for the trend of conditions to be appreciated by the legislators. Most assuredly, say these observers, when once Congress comes to a realization of the manner in which the public funds are being expended in wasteful business activities, a change of affairs will be forthcoming.

The certainty of mind in this connection is bolstered by the fact that the platforms of both major political parties strongly contend that the government should be kept out of business. Stress is being laid upon the fact that the nation has developed under the individualistic theory of government, and not under the socialistic. To quote from a recent decision by the Supreme Court of South Dakota, "The constitution and laws of the United States and of the various states have been framed under a policy having primary regard for individual rights."

The number of individual industries that are mustering for the present attack on bureaucracy indicates the great variety of industrial enterprises into which the governmental units have thrust themselves. At the preliminary meeting held in Washington October 20, representatives of more than a score of major industries cited case after case to show the scope of this intrusion.

Now that the situation is crytalizing, it may be expected that conditions which individual minds have long known to exist will be forced into a position where a critical survey will be inevitable.

Among the charges which the meeting next month may be expected to develop for the attention of Congress, government officials and the public are the following:

1—Penetration of government bodies into business denotes almost invariably an effort by those in public office to perpetuate their tenure.

2—Lack of successful methods, efficient management and the driving force created by prospects of genuine industrial progress forces government production costs higher than those of private business organizations.

3—Government enterprises, usually launched under the pretext of saving money through elimination of private profit, almost invariably result in the wasting of public money, with the losses concealed by refusals to employ cost accounting systems that truly indicate expenses involved.

4—Extension of business activities in the realm of government is in exact accord with the dictates of the basic theories of communism.

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Announcement is made of the purchase of the Crescent Silica Company of Ottawa, Ill., by the Standard Silica Company of Ottawa and Chicago, manufacturers of Blackhawk brand steel molding, foundry, and glass sands. By this purchase the Standard acquires 82 acres of land in the heart of the Ottawa district, with a modern concrete and steel washing and drying plant, and other equipment. The capacity of Standard is doubled by this acquisition.

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## Pulverized Coke Braize Firing

(Continued from page 494)

A screen separation mill is the only practicable machine for grinding materials of this nature, for with an air separation machine the abrasion on the exhaust fan, piping and cyclone will amount to as much as the repair cost of grinding elements in the mill proper.

Thus it appears that there are certain conditions which justify firing of coke braize in pulverized form. Few operators can afford to neglect consideration of this in designing or rehabilitating plants. Decision in each case will depend on the character and quantity of coke braize available, the price at which it can be produced and various other factors. With regard to abraiseveness, by means of tumbler tests, the pulverizer maintenance cost to be expected may be predicted with reasonable certainty. Years of experience have taught the proper line of demarcation between successful and unsuccessful applications of pulverized coke braize firing. This experience is available to those interested without charge.

# BY-PRODUCT AND CHEMICAL NEWS

In order to augment the gas supply of Buffalo, N. Y., the Iroquois Gas Corporation has determined upon the installation of a comprehensive plant equipment for the manufacture of carburetted water gas and have executed a contract with The U. G. I. Contracting Company of Philadelphia for the installation. The new plant installation is to be made at the Mineral Springs Gas Plant at Winchester, N. Y., and will consist generally of a 12-ft. diameter hopper bottom cone top U. G. I. water gas apparatus, together with Model "B" automatic control and U. G. I. barring down machine. Installed with the water gas set will be a U. G. I. vertical waste heat boiler built for working pressure of 160 lbs. There will also be installed a tower scrubber and tar separator. This plant will be in service about January 1st.

The Connectitcut Light & Power Company has arranged with The U. G. I. Contracting Company, Philadelphia, to remodel the carburetted water gas apparatus at the Norwalk plant. This remodeling will include the installation of a new generator complete, air and steam controls and various other additions to the apparatus and plant.

Due to the success attending the use of the Pier Process, the Public Service Electric & Gas Company of New Jersey has determined upon its use and has placed an order with The U. G. I. Contracting Company of Philadelphia, which controls this process, for an installation to be made at its Paterson, N. J., plant. The use of the Pier Process makes possible successful and economical use of 100 per cent bituminous coal in water gas manufacture.

The U. G. I. Contracting Company of Philadelphia has been awarded contract by the Hartford City (Conn.) Gas Light Company to furnish and install an 11-ft. U. G. I. cone top carburetted water gas apparatus with the necessary auxiliary equipment. With the apparatus there will also be installed the U. G. I. Model "B" automatic control, the U. G. I. thermo control and connections for the use of exhaust steam in the generator.

In order to meet the increased demand of its territory, the Orange County Public Service Corporation has arranged with The U. G. I. Contracting Company, Philadelphia, for the installation of additional equipment at the Middletown, N. Y., plant. This will include the installation of the 7-ft. U. G. I. water gas set, together with the necessary auxiliary equipment. This apparatus will greatly increase the daily capacity of the Middletown plant.

At the last meeting of the board of directors of the Linde Air Products Company, Mr. G. W. Mead, formerly president, was elected chairman of the board. Mr. W. F. Barrett, formerly vice president, was elected to the presidency. In addition to these changes, Mr. R. R. Browning was elected vice president in charge of sales activities, and Mr. J. A. Rafferty, vice president in charge of engineering, manufacturing and research.

## Recent Developments in European Gas Plants

During the past few months several interesting processes and plants have been developed for the purification of city gas. For instance, E. Urbain of Paris proposes to attain a greater degree of gas purification by bringing these gases, after they have been freed from tarry matter, into contact with absorbent carbonaceous materials having similar properties in a series of vessels so as to remove (1) the sulphuretted hydrogen in the state of free sulphur by oxidation, (2) the ammonia in the state of ammonium sulphite by causing it to react in the presence of the carbonaceous material with water vapor and sulphurous acid, and lastly, if desired, the carbonic acid; and subsequently the absorbed products by any of the known methods.

In another process, patented by J. Cobb and H. J. Hodsman of Leeds, the manufactured gas is subjected to the action of contact materials, such as iron oxide adapted to secure the partial oxidation of the hydrogen sulphite under conditions of temperature and humidity which will insure that the free sulphur formed shall be carried forward from the contact bed and that the latter maintains its activity, and utilizing ammonia to enable the removal of sulphur dioxide present after partial oxidation of the hydrogen sulphide to be effected by condensation and washing operations. The ammonia content of the gas is adjusted to insure that, under the conditions in which the treatment with hot iron oxide and the further treatment of the gas is carried out, the acidic oxygen containing sulphur compounds may be effectively removed. After subjecting the gases which have passed through hot iron oxide to condensing and washing processes, they may be passed through a cold oxide purifier to remove any residual hydrogen sulphide.

The following example of the action of the process has been given. A city gas, with the following composition by volume when purified, was treated:

| | |
|---|---|
| $CO_2$ | 3.0% |
| $C_nH_m$ | 2.5% |
| $O_2$ | 1.0% |
| CO | 13.0% |
| $CH_4$ | 24.5% |
| $H_2$ | 37.0% |
| $N_2$ | 19.0% |

The gas entering the purifiers, in which the iron oxide was maintained at a temperature of 300 deg. C., contained per 100 cu. ft. 140 grains of ammonia, 570 grains of hydrogen sulphide and 1.9 per cent by volume of oxygen. On leaving the apparatus 50 grains of ammonia, 80 grains of free sulphur as hydrogen sulphide and none as sulphur dioxide, and 0.5 per cent of oxygen were present in each 100 cu. ft. of the gas after washing.

A new device for locking purifier lids, has been developed by one of the leading British contractors. In this device use is made of hooked links pivoted to the cover or lid of the purifier, or to brackets fixed to it, and rotating shafts with cam-shaped projections. The shafts have bearings in the wall of the purifier or in the brackets in such a way that the cams effect the operation of the links to bring the hooked extremities beyond the plane in which lie the pivots of the links and the shafts. The shafts may each have a second radial projection against which the body of the link abuts when the lid is locked in position—this acting as a stop. A further releasing projection is provided on each of the rotating shafts, so located that, on the rotation of the shaft to unlock the hooked link, it advances into contact with the link and forces it outward to prevent it from catching or partially locking itself.

An improvement has been effected in the ordinary type of grids for purifiers in which two rows of bars are separated by bearer bars so that the rows break joint. In the improvement a series of pockets is formed between the two rows of bars in each grid, which assist in supporting the purifying material in superimposed layers, preventing each layer from unduly settling and varying in density, or the upper layer from falling or settling upon and compressing or increasing the density of the layer below. Only one upper grid is necessary in purifiers 4 ft. deep above the bottom grids, or two upper grids for purifiers 5 ft. or 6 ft. deep. The grid embodies two rows of bars for supporting the purifying material. The bars are arranged a predetermined distance apart in each row upon tie rods or cross-pieces of timber, which pass through mortised holes and are prevented from shifting their positions by dowel pins or nails. A layer of these supporting bars with their cross-pieces is arranged upon each side of bearer bars or distance pieces running at right angles, and the bars in each row are so arranged that they break joint with the bars in the other row.

Another firm of British gas plant contractors has designed an appliance with the object of making leather facings suitable for rendering disc valves gas tight. The designers have utilized a prepared leather, having ascertained that leather sufficiently impregnated with ordinary cod liver oil is admirable for this purpose. In practice, the leather is soaked in the oil for about three days at atmospheric temperature.—C. H. S. Tupholme in Gas Age-Record.

## Wheeling Steel Expands Coke Capacity

The Wheeling Steel Corporation has announced the award of a contract to The Koppers Construction Company, Pittsburgh, for the installation of additional coke ovens at East Steubenville, W. Va., which will increase their coke production 50 per cent.

There are to be 51 new ovens with a capacity of 500 cubic feet each. These will be the latest Becker type regenerative ovens and are to be completed in about eight months.

The greater part of the coke produced by the present facilities at the East Steubenville plant of the Wheeling Steel Corporation is used at the blast furnaces located at the Steubenville Works, directly opposite the coke plant on the west side of the Ohio River, being connected by the Corporation's bridge. The present production of coke has not been fully adequate for the furnace requirements at the Top Furnace, Wheeling, and Martins Ferry Furnace, Martins Ferry, Ohio, owned by the Corporation though the excess not now required by the Steubenville Works added to the new production will meet the needs of the Wheling and Martins Ferry furnaces.

The new ovens when completed will be designed so that producer gas for heating purposes can be used in the future, thereby releasing all of the coke oven gas for use at the Steubenville Works. An increase of 5,000,000 cu. ft. of gas so provided will be utilized in the Tube and other departments of the Steubenville Works.

Twenty-seven hundred tons of coal, it is estimated, will be coked in a 24 hour day when the additional ovens are installed and put into operation with the present ovens. Recovery of by-products will be increased as follows: 27,000 gallons of tar, 34 tons of ammonium sulphate, 8,000 gallons of benzol products and 18,000,000 cu. ft. of gas per 24 hour day.

The major portion of the coal for coking purposes is provided by the Wheeling Steel Corporation mine at Harmarville, linked by the river with the coke plant at East Steubenville.

## "The Human Factor"

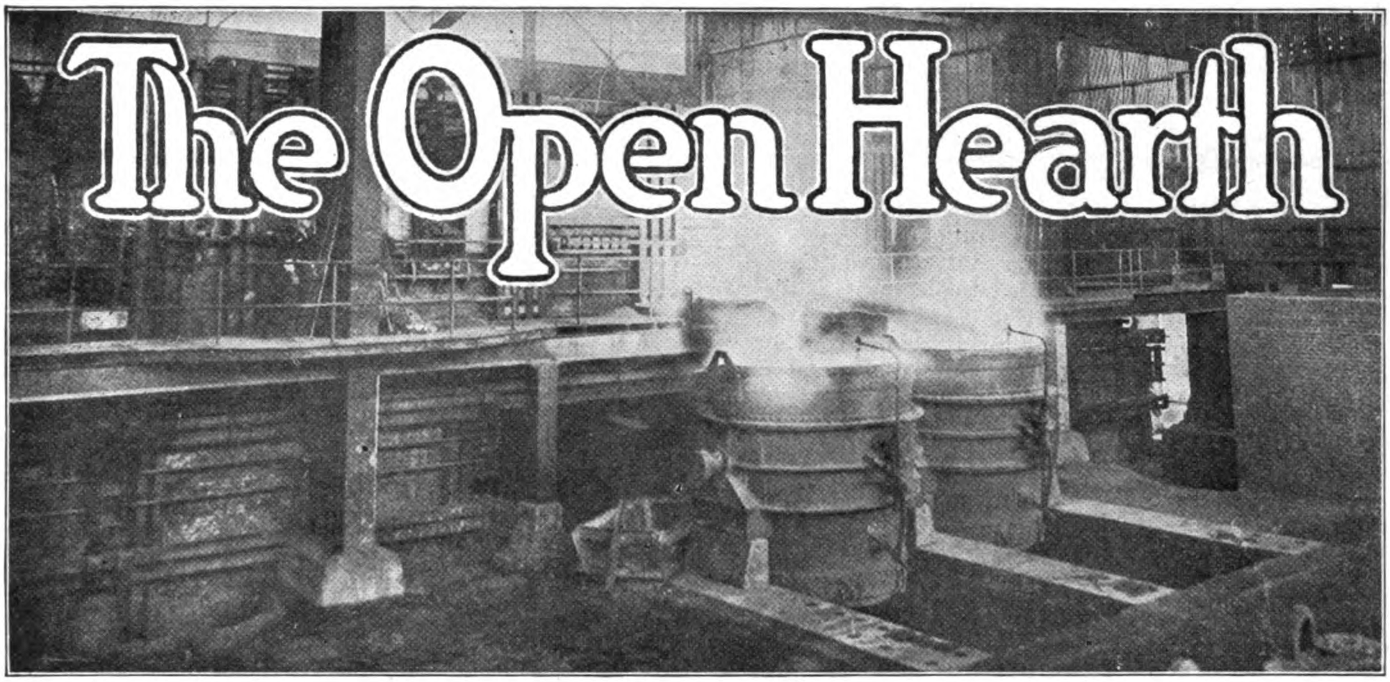
The Massachusetts Society for Mental Hygiene on November 15th issued the first number of a new bulletin which it will publish regularly as a definite part of its program. This new bulletin is called "The Human Factor," is expressly gotten up for the busy executive in business or industry, and is largely concerned with the innumerable every-day problems of industrial relations.

It is intended that this new bulletin will appeal strongly to employers, personnel workers, educators in stores or factories, management executives, employment managers, physicians, and all others who are in any way concerned with the human factor in business or industry. The columns of this new publication will be kept newsy and interesting and will be written in non-technical language. At the same time every care will be exercised to see that whatever is presented is sound and practical. In this unique way it is hoped to bring the principles of mental hygiene into the every-day life of business and industrial institutions and to make positive and definite contributions to the health and happiness of workers, who are a great and important part of our population, as well as to their productivity.

This new publication, which will generally consist of from four to six pages, will at first be issued quarterly; it will be sent free to members of the Massachusetts Society for Mental Hygiene and on request to all residents of Massachusetts who by occupation or profession are interested in the human factor in business or industry.

"The Human Factor" is under the editorial direction of Dr. Henry B. Elkind, medical director of the Massachusets Society for Mental Hygiene, who brings to his new task his large experience in the industrial and business field. He will be assisted by an unusually able consulting editorial board composed of well-known men: Daniel Bloomfield, Boston Retail Trade Board; B. Preston Clark, Plymouth Cordage Company; Dr. A. B. Emmons, and others.

# The Open Hearth



An additional open-hearth furnace was placed in operation at the American Steel Foundries, Granite City, Ill. This furnace has been down since the middle of August.

Work is proceeding rapidly on New England's blast furnace on the Mystic River, Everett, Mass., near Boston. The plate work is now complete on all the stoves and on the stack, and the brick work on both has been started. The structural steel is being furnished by McClintic-Marshall Company, Boston, the plate work by William B. Pollock Company, Youngstown, Ohio, the bridge by Mead-Morrison & Company, East Boston, and brick work by Shea-Whelpley & Company, Cleveland.

Henry T. Chandler has been appointed assistant to A. A. Corey, Jr., president of the Vanadium Corporation of America, effective November 10. Mr. Chandler had been with the company since January 1, 1923 as metallurgical engineer in Detroit. In his new position he will have general supervision of the research work in the Vanadium Corporation of America, and its subsidiary, the United States Ferro Alloys Corporation.

Edward E. Roberts has been appointed special representative in Buffalo and the western part of New York State for the Firth-Sterling Steel Company.

W. A. Edwards, formerly Chicago district manager for the Ludlum Steel Company, has been transferred to Houston, Texas, as manager of the southwestern territory for that company, P. E. Floyd will succeed Mr. Edwards in the Chicago territory.

E. Von Maltitz, formerly metallurgical engineer of the Illinois Steel Company, Chicago, has associated himself with H. A. Brassert & Company, that city, consulting engineers, to take charge of their work in the field of special steels.

The Weirton Steel Company, Weirton, W. Va., has taken the first step in its big program of plant betterments by placing the contract for the loading and unloading dock with the Dravo Contracting Company Pittsburgh. The dock will be 610 ft. long and of reinforced concrete construction.

The Bethlehem Steel Company has received a contract for the 8,750 tons of steel for the new Peace Bridge to span the Niagara River between Buffalo and Fort Erie, Ont., piers for which are now being laid.

F. A. Shick was elected a director of the Bethlehem Steel Corporation at the last meeting of the board to fill a vacancy. He is comptroller of the organization.

Charles Piez, chairman of the Link-Belt Company, Chicago, has been renominated for the presidency of the Illinois Manufacturers association, having held that office during the past year.

Judge E. M. Wilson, president of the Pacific Coast Steel Company, San Francisco, has been elected president of the Southern California Iron & Steel Company of Los Angeles to succeed C. A. Denman, recently resigned.

H. T. Herr, vice-president Westinghouse Electric & Mfg. Company in charge of the South Philadelphia works, hereafter will have the general management of the Philadelphia plant as well as the stoker works at Attica, N. Y.

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The Gulf States Steel Company, Alabama City, Ala., is arranging for immediate expansion at its local mill, primarily for larger steel bar output, and has foundations in progress for a portion of the equipment to be installed. It is expected to develop a gross capacity of 300 tons per day, or more than double the former output. The company has recently acquired the bar mill of the Forged Steel Wheel Company, Butler, Pa., and will remove this equipment to the Alabama City mills.

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The Columbia Steel Corporation, San Francisco, Cal., has acquired iron ore properties at Iron Mountain, Utah, heretofore held by the Milner-Dear-Leach Company, totaling more than 900 acres, and plans for extensive developments in the near future.

# NEWS OF THE PLANTS

The Youngstown Sheet & Tube Company, Youngstown, Ohio, had foundations in progress for its proposed new mill units at Indiana Harbor, Ind., consisting of four one-story structures to be used as a hot roll mill, annealing and cold mill, pickling building and bar storage structure. The mills will cost close to $450,000, and will be supplemented with a number of other buildings at a later date. The complete project will represent an investment of more than $4,000,000, including equipment.

The Kansas City Steel Corporation, 1016 Commerce Building, Kansas City, Mo., has plans nearing completion for its proposed new mill on site recently acquired in the Blue Valley district. It is expected to proceed with work on the initial buildings at an early date. The company has acquired the plant and business of the Cromwell Steel Company, Lorain, Ohio, and will remove the equipment to its new works, with the installation of other machinery for considerable increased output. J. W. Dana is president of the company, and Daniel C. Hayne, chief engineer.

The New Process Iron & Steel Company, Noblesville, Ind., is arranging for the operation of two new mills which have been in course of construction for several months past, consisting of a 16-inch finishing mill, and 24-inch break-down mill. The company purposes to reroll billets for the commercial market, in sizes ranging from 4 to 6 inches. It is said that expansion in other divisions will be carried out in the near future.

The Donner Steel Corporation, Buffalo, N. Y., has filed plans for the construction of two new buildings at its plant, on which work will begin at an early date. The expansion will consist of a one-story roll shop and one-story finishing mill, to cost approximately $75,000; the structures will be located on Abbott Road. A list of machinery to be installed will be arranged at an early date.

The Crucible Steel Company of America, Pittsburgh, Pa., has begun work on an extension and improvement program at its local Park works, and purposes to provide facilities for large increase in capacity. A number of new buildings will be erected, including a 22-inch billet mill. The present blooming mill will be rebuilt and considerable new machinery installed, including a manipulator, delivery and entering tables. The expansion provides for a change from steam power to electric operation, and calls for the installation of motors and other industrial electrical equipment. The entire program will represent an investment of close to $500,000, with machinery.

The McClintic-Marshall Company, Pittsburgh, Pa., has completed plans for an addition to its steel fabricating works on Dante Ave., Chicago, Ill., and will push construction on the project for early completion. It will be one-story, 100x200 ft., estimated to cost in excess of $50,000, with equipment. F. W: Hughes is company engineer, in charge. The company has recently placed its new fabricating shops at Los Angeles, Cal., in service, and expects to develop this plant for large output for Pacific Coast trade. The main structure is 90x350 ft., with a 60x250-foot building and smaller structures adjoining.

The Northwest Steel & Metal Products Company, Seattle, Wash., will soon begin the construction of a new individual steel mill unit on site selected on the Lake Union Canal, between Ninth and Eleventh Aves., N. W. The works will consist of several buildings, reported to cost close to $300,000, including machinery. A list of equipment to be installed will be arranged at an early date.

The Dominion Alloy Steel Corporation, Sarnia, Ont., has work in progress on a new sheet mill at its plant and proposes to have the unit ready for active service at an early date. It will be used for the production of black sheets, and is reported to represent an investment of more than $400,000. The initial unit of the local plant, now in operation for a number of months, is given over to the manufacture of galvanized sheets and the company expects to develop an extensive output in this line.

The Penn-Seaboard Corporation, Philadelphia, Pa., is proceeding with proposed extensions and betterments at its New Castle, Del., works, and has now arranged for the installation of four new bar mills in addition to other units, recently announced. The new equipment to be installed will be electrically-operated. The company purposes to develop the plant to a point of finished products, and will expand operations in this line. J. B. Warren is president.

The Trumbull Steel Company, Youngstown, Ohio, has resumed work on an expansion program inaugurated a number of months ago and discontinued in August owing to reorganization of the company. The project includes the construction of new buildings and the installation of additional equipment. Foundations are in progress for a new open-hearth furnace, making the eighth such unit at the mill, and it is purposed to proceed with this part of the program during the coming year. Other increases for raw steel requirements will also be carried out. In connection with its reorganization, the company has arranged a bond issue of $13,000,000, a portion of the fund to be used for the plant extensions. Philip Wick is president.

The Pacific Coast Steel Company, San Francisco, Cal., has acquired control of the Southern California Iron & Steel Company, Los Angeles, Cal., and will operate as a new division of its works. The purchasing company is said to have plans under advisement for extensions and betterments for increased output. A. C. Denman, Jr., heretofore president and general manager of the acquired company, has retired from the business.

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